KU LEUVEN

FACULTEIT SOCIALE WETENSCHAPPEN

The use of environmental taxation as a regulatory policy instrument

Kris BACHUS

Proefschrift aangeboden tot het verkrijgen van de graad van Doctor in de Sociale Wetenschappen

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[Universiteit Gent]

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Abbreviations

BC	before Christ
CAC	command-and-control
CDM	Clean Development Mechanism
CO_2	carbon dioxide
COP	Conference of the Parties
CPI	Consumer Price Index
DOI	digital object identifier (to identify electronic articles)
ECR	effective carbon rate
EHS	environmentally harmful subsidies
EPR	extended producer responsibility
ET	environmental taxation or environmental taxes
ETR	environmental tax reform
ETS	emission trading scheme
EU	European Union
GHG	greenhouse gas(es)
GDP	gross domestic product
l	litre
MAC	marginal abatement cost
MDC	marginal damage cost
MLP	multi-level model
MPP	multi-phase model
NATO	nodality, authority, treasure and organization
NDRC	National Development and Reform Commission (of China)
NMVOC	non-methane volatile organic compounds
NOX	nitrogen oxide gases, such as NO and NO2
OECD	Organisation for Economic Cooperation and Development
OLS	ordinary least squares
PM	particulate matter
PMM	policy-making models
R & D	research & development
SO2	sulphur dioxide
tce	ton coal equivalent (Mtce = million tonne coal equivalent)
TLC	technology life cycle
UK	United Kingdom
UNEP	United Nations Environment Programme
US	United States
VAT	value-added tax
WTP	willingness to pay

Acknowledgements

Doing a PhD is a very personal project, which cannot be compared to any other aspect of the job of a researcher. Many people start a PhD, but only few really know what they can expect from the challenge, and many realize along the way that it may not have been the best decision for them after all. Personally, I believe that starting a PhD project right after master degree graduation is a leap in the dark for most people. Maybe that is why I did not decide to want to start a PhD project for the first twelve years of my career in research. But when you take the plunge after such a history of academic and policy-supporting research, you really know what to expect and why you want to do it. Probably that is why, to me, doing a PhD has been an enriching, inspiring and rewarding exercise.

Although a PhD is an individual and sometimes lonely test, this feat would not have been possible without the help of many of my colleagues and relatives. First of all, I want to thank my supervisor Marleen Brans and my co-supervisor Luc Van Ootegem for their dedication, their trust, and their valuable feedback; it is beyond any doubt they have lifted my work to a substantially higher level. Next, I thank the other members of my examination committee, Katja Biedenkopf, Erik Mathijs, Mikael Skou Andersen and Sven Rudolph for their valuable feedback and constructive discussions.

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Combining a PhD with the job of research manager at HIVA is a daunting challenge at times. Finishing it in 2017 would never have been possible without the support of my head of research Huib Huyse and my director Manu Gerard. They trusted me enough to allow me to let me go to China for three and a half months for the main writing effort of my PhD thesis. I was probably the first (and only?) person who regarded this 'sword of Damocles' mission as a positive challenge rather than a threat.

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X

Introduction

At least since the Greek empire, around 500 BC, reigning authorities reportedly have been making efforts to tackle the environmental problem of waste, because it caused nuisance, smell and disease. Other environmental problems were added to the list later, especially in the 20th century, including air pollution, biodiversity loss, water pollution, deforestation, acidification, the ozone layer and more recently the global concern for climate change, which has grown out to be the most serious global environmental concern. Throughout history, legal instruments such as standards and permits have dominated environmental policy-making. It was not until 1920 that an academic first suggested the use of taxation as a regulatory instrument to tackle environmental problems, also called environmental externalities (Pigou, 1920). And although some countries introduced a tax on petrol as early as in the 1930s, only in the 1970s the first taxes with an explicit environmental goal were launched.[1] Even if their use has increased considerably since then (Jordan et al., 2003), the tax instrument is nowadays still used less than command-and-control policy instruments (Oh & Svendsen, 2015). That observation is interesting, considering the strong support environmental taxes receive in (particularly economic) studies, both from academics and international institutions such as the OECD and the European Commission.

This paradox is the starting point for this PhD study on the use of taxation as a regulatory instrument in environmental policy. Several perspectives on this instrument will be investigated, including the position of taxation within different typologies of policy instruments and decision-making models, the comparison of environmental taxes with related instruments such as tradable permits, their use in policy mixes, their measurement, their side effects such as competitiveness and regressivity, their potential contribution to sustainability transitions, and their public support.

The PhD is a *publication-based PhD*, which means that four academic publications (paper 1, 2, 3 and 4) constitute the core of the dissertation, supplemented with an introductory chapter and a concluding chapter.[2] This introductory chapter describes the scope of the PhD study and lays out how the four publications contribute to answering the research questions of the PhD. The

[1] For example, petrol taxes were introduced in Norway in 1931; the first regulatory tax with an environmental goal was the sulphur tax in 1971 (Sollund, 2007).

[2] Note that the four papers are included in this dissertation *ad verbatim*, as they have been published in the books or journals. The consequence is that some style, spelling or layout differences may exist between chapters. For example, some elements of the journal's layout may be kept and the use of commas, capital letters of other style elements may not be fully coherent in the dissertation. This is largely the result of journal or editor style rules.

concluding chapter presents the main horizontal findings and the answers to the research questions.

In the first section of this introductory chapter, I formulate the problem definition and the objectives and research questions of the PhD. The second section provides an overview and definition of the concepts that are recurrently used in this dissertation. The third section elaborates the theoretical framework and analytical concepts of the PhD. Four theoretical strands will be discussed: instrument theory, Pigouvian taxation (including the analytical concepts of competitiveness and regressivity impacts), sustainability transition theories and theories on public support for environmental taxation. In the fourth section the methodological and empirical approach of the PhD study is reviewed. The fifth part describes the four papers that constitute the core of this thesis:

- **Paper 1**: comparison of a tax instrument and an emissions trading scheme in the context of climate change policy, including a case study on China.
- **Paper 2**: evaluation of the existing indicators for measuring the greening of a tax system and development of a new type of aggregated indicator, based on index theory.
- **Paper 3**: confrontation of the theory of environmental taxation with the theory of sustainable transitions thinking.
- **Paper 4**: theoretical and empirical study on public support for environmental taxation, including an empirical part based on a survey in Flanders.

Figure 1 shows a flowchart of the structure of the PhD thesis.

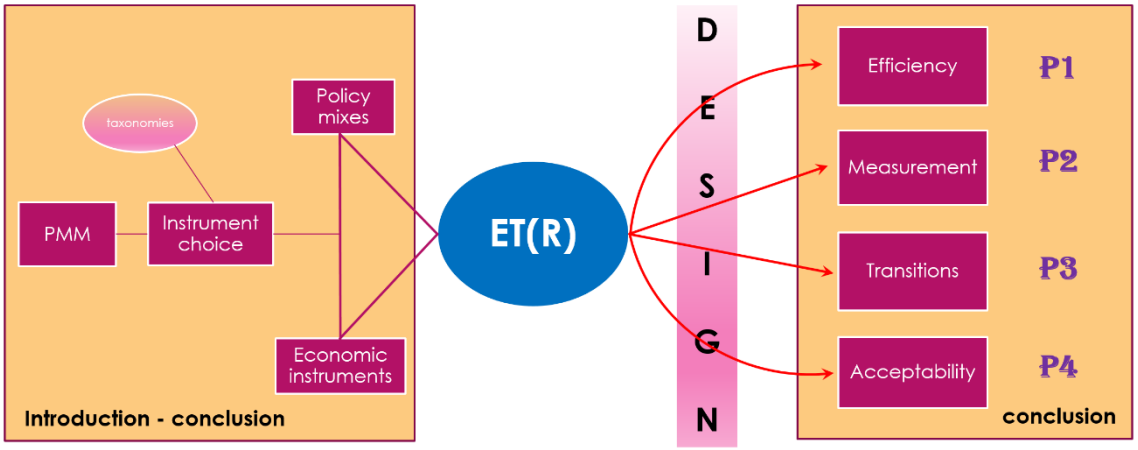


Figure 1. Visualisation of the structure of the PhD thesis

PMM = policy-making models; ET = environmental taxation; ETR = environmental tax reform; P1 = paper 1, etc.

The place of ET and ETR in the literature of policy-making models is discussed in this introductory chapter (3.2.1 and 3.2.2) and in the conclusions of this PhD. Taxonomies of environmental policy instruments are presented in section 3.2.3, instrument choice is discussed in section 3.2.4, and policy mixes in section 3.2.5. Environmental tax design is considered as a cross-cutting issue, which returns in all four papers of the PhD. The conclusions of the PhD dissertation will cover all topics treated in the introduction and in the four PhD papers.

1 | Problem definition and research questions

Three levels of research questions are distinguished to encompass the scope of this PhD study: one central (level 1) question, three underlying (level 2) questions and eight operational (level 3) questions. The central (level 1) research question of this PhD study is

"*How can the use of ET as a regulatory policy instrument be **explained**, **measured** and **optimized***?"

This central question harbours three underlying (level 2) questions, which have arisen from observed gaps in the literature, and which can be further subdivided into eight more operational (level 3) questions. For each of these level 3 questions, a reference to the chapter where it is discussed, is added.

1. Which mechanisms **explain** how policy decisions, including instrument choice, are made?
   → Related subquestions:
   - [Q1] How can the choice for ET be explained using theoretical policy-making models? (introduction)
   - [Q2] How does ET compare to other policy instruments? (introduction, paper 1)
   - [Q3] How can the (under)use of ET in practice be explained? (introduction, paper 3, paper 4)
2. How can the use of ET, or the greening of a tax system, be **measured**?
   → Related subquestions:
   - [Q4] How can different types of indicators for measuring the greening of a tax system be evaluated? (Paper 2)
   - [Q5] Which alternative aggregate indicator(s) can be developed to improve the existing set of indicators? (Paper 2)
3. How can the use of ET be **optimized**?
   → Related subquestions:
   - [Q6] Which policy instrument is the optimal climate mitigation policy instrument for the case of China, a carbon tax or an emissions trading scheme? (introduction, paper 1)
   - [Q7] What is the potential of environmental taxation as a policy instrument for fostering sustainability transitions? (paper 3)
   - [Q8] What are the factors determining public support for environmental tax reform and how can this support be increased? (paper 4)

Rather than addressing a specific gap in the literature, the first level 2 research question refers to the state-of-the-art of the literature on the topic of environmental taxation. The state-of-the-art is the main topic of this introductory chapter. ET is discussed using the literature on instrument choice and policy-making models (Q1). The use (or underuse) of ET as a policy instrument is explained using these frameworks (Q3), as is the relation between ET and other policy instruments (Q2).

The second level 2 research question arises from an important gap in the literature. The predominantly used revenue-based indicators to measure and compare national governments' use of environmental taxation suffer from serious validity problems. As the indicators are mainly

used in the policy arena (e.g. European Commission & Eurostat, 2016), the academic community has up to now hardly taken notice of the validity problems, even though scholars recurrently make use of the common indicators (e.g. Hsu, 2009). There was a strong need for the development of alternative indicators in the academic field. This observation led to level 3 subquestions Q4 and Q5 which this PhD aims to answer: "*how can different types of indicators for measuring the greening of a tax system be evaluated, and which alternative aggregate indicator(s) can be developed to improve the existing indicator set?*" (**paper 2**).

The third level 2 research question of this PhD study concerns the optimization of environmental taxation as a policy instrument. In Q6, the undecided debate, both in academic and policy fields, comparing taxation and tradable permits, is addressed. Taxes may be in use for longer than emissions trading, but as soon as the trading instrument appeared, economists and policy analysts alike have been debating which one of them is 'the best' instrument for resolving environmental problems. As is often the case, there is no clear-cut answer to this question, since the specific design of the instrument, the market structure and the context within which the instrument is used, need to be taken into consideration. As the policy debate in China on the choice between these two market-based instruments was at its height in 2013, I chose to contribute to that discussion by applying the instrument choice decision both in theory and in practice to the case of China. This focus led to subquestion Q6 of this PhD study: "*Which policy instrument is the optimal climate mitigation policy instrument for the case of China, a carbon tax or an emissions trading scheme?*" (**paper 1**). Second, a gap in the literature was found in the emerging field of sustainability transitions. Based on other theoretical bodies, sustainability transitions scholars created a new theoretical school related to the analysis of and the solutions to persistent environmental problems. Only few scholars in this new field made the link between persistent environmental problems on a socio-technical system level and economic instruments as potential solutions. Consequently, there was room for subquestion Q7, which is "*what is the potential of environmental taxation as a policy instrument for fostering sustainability transitions?*" (**paper 3**). Third, yet another gap in the literature relates to the importance of public support as a criterion for instrument choice. A lot of literature can be found discussing public support for several policy instruments, including taxation, but only a very small part has a specific focus on regulatory environmental taxation. This conclusion led to subquestion Q8: "*what are the factors determining public support for environmental tax reform and how can this support be increased?*" (**paper 4**).

In the concluding chapter of this thesis, the research results are integrated and the research questions are answered in a systematic way. Transversal conclusions are formulated, next to reflections on questions for future research.

2 | Conceptual framework

In the field of environmental taxation, many terms are in use, some of which are similar to each other, but with subtle differences that can be important. In this section, I present the most important concepts used in this dissertation.

The term '**policy instrument**' is so common and (seemingly) trivial that not many scholars spend time defining it.[3] Yet, many different interpretations of the term can be found in literature, ranging from a narrow to a very broad concept of a policy instrument. Several authors prefer the term 'tools' over instruments, as this has a broader scope (Hood, 1983; Peters & van Nispen, 1998). The topic of this PhD is the use of the instrument of taxation as a tool to push people's and companies' *behaviour* in a direction that benefits the environment. Given that behavioural focus, we choose to use a definition based on van den Heuvel (2005)[4]: "a tool that a government actor uses to achieve a certain impact on the behaviour of the target group".

Two closely related terms are **environmentally related tax** and **environmental tax**. The former is defined by the OECD (2001, p. 15: 16) as "*any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance*". This definition contains the compulsory and unrequited characteristic of any tax, and the environmental component is defined by the *tax base*, for instance the volume of natural gas used for heating a home. The choice to use the tax base is important, as it creates a difference between an 'environmentally related tax' and an 'environmental tax'. Bruvoll (2009) relates the environmental component of an environmental tax to the *objective* of the tax: a tax can only be an environmental tax if it has an environmental objective. This interpretation of an environmental tax ties closely with the concept of the **Pigouvian tax** (see 3.3.1), which is a tax that aims at tackling environmental externalities. We also call this sort of tax a **regulatory tax**[5], since government aims to regulate or influence citizens', consumers' and companies' behaviour with it. Ekins (1999) calls this tax an **incentive tax** and Owen (2004) refers to it as an **externality tax**.

At first sight, Bruvoll's definition of an environmental tax seems to fit best with the focus of this PhD study, which is environmental taxation *as an instrument for environmental policy*. However, the OECD term has the advantage of being more straightforward: it is possible to determine objectively whether a tax has a tax base that is relevant to the environment, but it is much harder to identify the policy makers' precise objectives when they introduced the tax. For example, excise taxes on diesel and gasoline were introduced in Belgium as a revenue-raising tax in 1971, arguably with no environmental objective at the time. Since then, the tax has undergone multiple reforms (Bachus, 2016), after which one can argue that environmental concerns are at least part of its objectives. Moreover, most scholars in the field of environmental taxation do not take sides in this discussion, and use Bruvoll's narrow term 'environmental tax' in the broader OECD sense, thus avoiding discussions about the objective of the tax. Although Bruvoll makes a valuable point, which is also acknowledged by the European Commission and Eurostat (2013), I will follow the large community of scholars and use the term 'environmental taxation' in the broad sense, meaning that the tax can be introduced for other than environmental reasons. Yet, when I will be dealing with measuring the greening of tax system (**paper 2**), I will

[3] Hood (1983, p. 2) does not give a definition but he sees policy instruments as the "administrative tools that government uses at the point where it comes into contact with 'us', the world outside"; and he compares them with tools for other purposes, such as for carpentry or gardening. Howlett and Ramesh (2003, p. 114) do give a definition: "the actual means or devices that governments make use of in implementing policies". A similar broad definition is found in Fenger and Klok (2003, p. 189): "a policy instrument is what is used or can be used by an actor to attain a certain goal" (translated from Dutch by the author)

[4] Modified and translated from Dutch by the author.

[5] In this PhD, the term 'regulatory' will be used in the broad sense, following Meier's (American school) definition: "Regulation is any attempt by the government to control the behavior of citizens" (Meier, 1985). In the standard English school, this term is defined more narrowly as all prohibitions and obligations imposed by government (Vedung, 1998).

use the term 'environmentally related taxes' to refer to the OECD definition based on the tax basis.

A typology of environmental taxation can be based on different distinguishing factors:

1. Objective: aimed at improving the environment (regulatory tax, Pigouvian tax), or at raising government revenue (revenue-raising tax, fiscal tax);
2. Sector or tax base: Eurostat distinguishes four areas: energy taxes, transport taxes, pollution taxes and resource taxes. Bachus (2016) uses an adapted framework to include the Belgian reality of shared competencies between the federal and the regional governments: energy taxes, transport taxes, Flemish environmental levies (including resource taxes) and federal product taxes;
3. Point of taxation: an environmentally related tax can be levied on input (e.g. energy consumption), emissions, products, processes, activities, waste generation, purchase, ownership, car registration or company profits (Verbruggen, 2007)
4. Taxation unit: a lump sum tax, an ad valorem tax (e.g. VAT), a specific tax (e.g. euro per litre of diesel purchased), a tax per unit of pollution or emission.
5. Level of differentiation in the tax level: a uniform tax or differentiated; for example: in most countries taxes on energy products are differentiated based on their use: diesel used as a transport fuel is taxed at a much higher level than the same energy product used for heating purposes.
6. Target group: citizens, consumers, companies or more narrowly specified groups.
7. Destination of the tax revenues:
    - Covering the cost of a system to cope with a related environmental issue, e.g. a tax (or charge) on water consumption to cover the cost of a wastewater treatment system;
    - General government budget;
    - The revenues are spent on other government objectives ('earmarked' or 'hypothecated' tax), which may or may not be related to the environment. For example, part of the revenue from a pollution tax that is spent on a subsidy programme for environment innovation R & D. Another example is the revenue of a new environmental tax used for lowering social security contributions, which can be labelled as an environmental tax reform (*infra*).
    - The revenues are used for compensating the target group of the environmental tax.
    - A mix of the above options.

A **tax expenditure** (or tax incentive) is any preferential rate on the benchmark level of a tax (Hoge Raad Van Financiën, 2002).[6] For example, excise tax rates on transport fuels in Belgium are 61 eurocent per litre for unleaded petrol, and 50 eurocent for diesel.[7] Whichever of those two (or the average) is considered as 'the benchmark level', it is clear that the zero excise tax level for air transport fuel (kerosene) is a tax expenditure (Bachus, 2016).

An **environmental tax reform** (ETR), or green tax reform, is the process of shifting the tax burden from employment, income and investment, to pollution, resource depletion and waste (OECD, 1997). If the reform shifts not only taxes but also subsidies towards more environmentally friendliness, it is often called an **environmental fiscal reform** or a green fiscal reform (Clinch et al., 2006).

6 Free translation by the author

7 Source: www.petrolfed.be, accessed 28 October 2016.

An environmental tax reform has two sides: an increase in environmental taxation and recycling of the government revenues elsewhere. The revenue spending can be done through lump-sum repayment, earmarking[8] for environmental purposes (see 3.5) or by removing other distortionary taxation such as labour and capital taxation. In policy circles the debate is often focused on a 'revenue-neutral' tax reform, in which case the tax reform aims at a balance between revenues and spending, with no impact on the total government budget. **Earmarking** or **hypothecation** is "*the term used to describe the process of assigning tax revenues to a specific end, or - in certain cases - ensuring that they are not spent on one particular end*" (House of Commons, 2011, p. 1)

As no definition of the concept of '**greening of a tax system**' is available in the literature, it is defined in **paper 2** as 'an increasing emphasis on the environment in the tax system'. This definition implicitly refers to the OECD term 'environmentally related taxes' (supra), which has a focus on the tax base, not on the policy objectives. This choice is consistent with the scope of paper 2. An alternative definition for the greening of a tax system may be based on Bruvoll's concept of 'environmental taxation'. That definition would then be 'the inclusion of environmental objectives in the tax system'.

A (pure) **public good** is a good that exhibits neither rivalry nor excludability, meaning that one agent's consumption is not at the expense of another's, and no-one can be excluded from consuming (Perman et al., 2003). A **property right** is "a bundle of characteristics that convey certain powers to the owner of the right" (Hartwick & Olewiler, 1986). An **externality** is "any valued impact (positive or negative) resulting from any action (whether related to production of consumption) that affects someone who did not fully consent to it through participation in voluntary exchange" (Weimer & Vining, 2017, p. 93). A (policy) **side effect** can be defined as unintended policy effects that may occur in or outside the field of the environment (Gysen et al., 2006). The difference with an externality is that a side effect may or may not have been compensated for, whereas an externality, by definition, has not been (fully) compensated. In other words: all externalities are side effects but not all sided effects are externalities.

Marginal abatement costs are a firm or industry's marginal costs to reduce pollution by one unit (McKitrick, 2015). In a similar vein, **marginal damage costs** are the marginal costs due to a one-unit increase in emissions (Tol, 2009).

A **transition** is a structural societal change resulting from mutually reinforcing developments in the economy, culture, technology, institutions, and environment (Rotmans, 2003)[9]. **Socio-technical systems** are "the linkages between elements necessary to fulfil societal functions (e.g. transport, communication, nutrition)" (Geels, 2004). Crucial elements to fulfil those functions include technology, culture, practices and structure (Geels, 2011).

[8] Although both earmarking and hypothecation refer to the designation of the revenues from a certain tax to any specific way of funding, we will use both terms in this PhD study only to refer to explicit environmental spending, such as environmental investments or environmental subsidies. In other words, we will use the terms 'earmarking' and 'environmental earmarking' as synonyms.

[9] Translated from Dutch by the author

3 | State-of-the-art

3.1 Introduction

The use of theory is an important tool for answering the research questions of this PhD study. Blaikie (2005) sees five ways in which theory can be used in research, in increasing order of complexity (levels):

1. Ad hoc classificatory systems, used to summarize data;
2. Categorical systems or taxonomies: mainly descriptive, but some "patterns of relationships" are indicated;
3. Conceptual frameworks: fully focused on explaining "patterns of relationships" and involving some causal connections;
4. Theoretical systems or "explanatory schemes": aim to explain certain phenomena.
5. Empirical-theoretical systems: Empirical testing of the theoretical ideas.

Theoretical systems (**level 4**) will be used in this PhD to explain *how* and *why* environmental taxation is used by policy makers (Q1 and Q3 of section 1), and to understand how environmental taxation can foster sustainability transitions (Q7). Theories on public support for ETR are empirically tested (**level 5**) in paper 4 (Q8), and the same is done with indicator theory and measurement theory in paper 2 (Q5). In most cases, Blaikie's **level 2 and 3** of theory use are useful in supporting the higher levels. The taxonomies discussed in section 3.2.3 (Q2) and the conceptual framework of section 2 illustrate this. For example, a clear understanding of the concepts externalities, property rights, side effects and Pigouvian taxes are indispensable for explaining the use (or non-use) of environmental taxation as a policy instrument.
The third level of theory, conceptual frameworks, includes the issue of 'operationalization'[10], which is the main topic of paper 2 (Q4 and Q5), where abstract theoretical constructs are translated into more operational ones and into indicators.
Conceptualization and operationalization are clearly intimately linked (Babbie, 2013), but I see them as equally important. Consequently, I believe operationalization, including measurement and indicator development, deserves to be called a sixth level of theory, to be placed after 'conceptual frameworks' and before 'explanatory schemes'.

Besides the five (or six in my version) uses and levels provided by Blaikie, a sixth (or seventh) use of theory can be added, which is *prediction* (Gilbert, 2003; Swanborn, 2015). The combination of explaining, establishing causal links and predicting the effects of the use of environmental taxation in China paved the way for paper 1 (Q6), and for the exploration of the impact of environmental taxation on sustainability transitions (Q7). Finally, theory can provide a strong basis for policy recommendations (Dooley, 2001), which is relevant for most parts and research questions of this PhD study, and specifically for the conclusions chapter, which includes policy recommendations.

There is no single theoretical framework of 'the use of environmental taxation as a policy instrument'. The study of the topic draws from various underlying theoretical bodies. In total four theoretical strands from both economic and political and social sciences will be studied and used in this PhD research.

[10] Operationalization is "the development of specific research procedures (operations) that will result in empirical observations representing abstract concepts in the real world" (Babbie, 2013, p. 177)

Instrument theory is the first theoretical body, which aims at explaining why and how policy decisions are made. We will discuss government policy-making models, typologies of policy instruments, and criteria for instrument selection.
The second theoretical strand is the theory of Pigouvian taxation, which fits into the theoretical school of neoclassical economics. Pigou's work can be regarded as the mother of all theories relating to environmental taxation, as it addresses the raison d'être for this instrument, namely the effect on the environment. Several other neoclassical scholars have further advanced Pigou's theory. Concomitant with the theory of Pigouvian taxation, the analytical concept of side effects of taxation as an environmental policy instrument is discussed. The two most studied side effects of environmental taxation, competitiveness impact and social impact (regressivity), will be discussed.
The third theoretical strand is transition theory, which originates from a multitude of underlying theoretical bodies (see 3.4) and has then evolved into an independent theoretical school with its own theoretical models such as the multi-level perspective (MLP) and the multi-phase perspective (MPP).
The fourth theoretical literature strand pertains to explaining public support for the use of environmental taxation by government. It addresses such questions as 'what determines whether certain policy interventions (such as the use of environmental taxation) get the support from the public?', and 'what impact does public support have on government decisions regarding the use of policy instruments (such as environmental taxation)? Theories used to address these questions stem from behavioural economics, instrument theory and psychology.

As explained higher in this section, this PhD study aims to use all types and levels of theory. Furthermore, it aims to distinguish itself from other studies by combining the four theoretical schools mentioned above, and by applying them to the research questions of the study. The objectives of combining the theories are twofold. First, I aim to explore (explain and predict) the potential of environmental taxation in several unexplored fields, such as transitions. Second, I aim to increase understanding on other fields, such as instrument choice, indicator development and public support. And third, I aim to provide (partial) answers to a broader, normative question, which is "why, when, how, in what situations and circumstances is it *legitimate* to use taxation as an instrument in environmental policy" (Bauböck, 2008)?

In the next section, the four theoretical bodies and analytical concepts are discussed.

3.2 Framing environmental taxation in instrument choice theory

Public policy-making is a complex process with many actors, interests, institutions, values, context factors, instruments, practices and cultures at work. All these elements combine in one way or another into a policy process, with instruments and other outcomes. Various analytical frameworks have been developed over time, aiming to better understand the policy process. Providing the full overview of these frameworks and their interactions exceeds the objectives of this PhD study on environmental taxation. However, understanding some of the dynamics of the policy process may contribute to understanding the reasons why environmental taxation has (or has not) been a much-applied solution in environmentally-related policy processes (research questions Q1 and Q3 of this PhD). As a corollary, one model explaining the stages in the policy process is explained (the 'stagist model' or 'the policy cycle') in section 3.2.1, and four models that offer insights on how the decisions in the policy process are taken by the actors involved are discussed in section 3.2.2. This type of models are often called 'decision-making models' (Howlett et al., 2009), but to avoid confusion with the 'policy decision' stage of the stagist model (see figure 2), I choose to call them 'policy-making models', as – in my view – they do not relate

to one stage of the policy process, but to the policy process as a whole. In the next subsections, the study zooms in on one (sub)part of the policy process, which is instrument choice. In the third subsection, some of the existing typologies of policy instruments are discussed, and in the fourth part I delve deeper into the question on which criteria governments base their instruments choice. In the fifth part, I introduce the notion of policy mixes, which will repeatedly be addressed in this PhD study, and in the sixth part I dwell on the policy relevance of instrument choice theories and instrument typologies. The seventh subsection is devoted to the important role of tax design in the context of the implementation of environmental taxation.

3.2.1 The stagist model

The policy cycle model, also known as the stagist model, was developed between 1950 and 1990 by various subsequent authors. It eventually became (and probably still is) the dominant heuristic for understanding the policy process (Howlett et al., 2017). As the name suggests, the stagist approach depicts the policy process as a cycle, and divides it into a number of successive phases or stages. Although many variants have occurred containing between three and seven stages, we choose the one presented in figure 2.

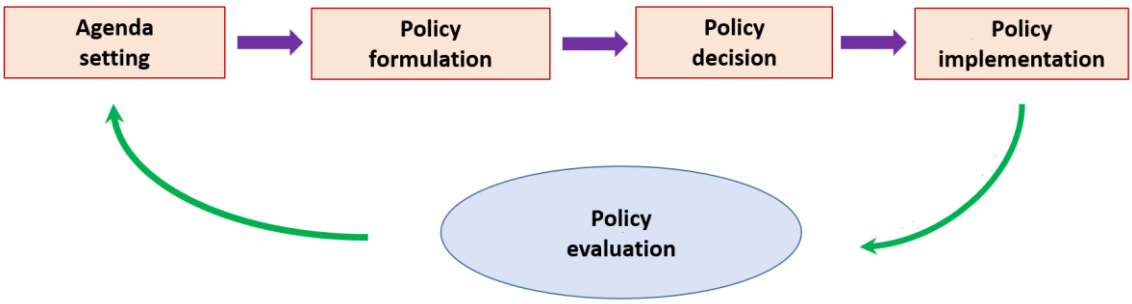


Figure 2. The policy cycle

Source: own presentation, based on Hupe and Hill (2006)

The most relevant stage for this PhD study is the instrument choice phase, which is situated in both the policy formulation stage and the policy decision stage. According to Howlett et al. (2009, p. 110), "*policy formulation involves […] exploring the various options or alternative courses of action available for addressing a problem. […] The range of available options considered at this stage is always narrowed down to those that policy makers could accept before these alternatives move on to the formal deliberations of decision-makers.*" In other words, in the policy formulation stage a limited number of options (instruments of instrument mixes) are offered to the (political) decision-making stage, where the options are further narrowed down to one.

The main merit of the policy cycle model is that it provides a simple and seemingly logical framework for the inherently complex policy process. In addition, it can be applied to all levels of government, from local to international. It also clarifies the role of all actors involved in policy-making.
However, the model has been heavily criticized by many scholars for being too simplistic, a heuristic, and not a causal model; for being inaccurate and for having a top-down and legalistic focus (Sabatier & Brasher, 1993; Hupe & Hill, 2006). It suggests that policy-making is an orderly and systematic process, which is not the case in reality (Howlett et al., 2009).

In spite of the criticisms to the model, the stagist model is still used by many public policy scholars, albeit mostly as a way to structure policy analysis handbooks rather than as a useful descriptive model for policy processes (e.g. Howlett & Ramesh, 2003; Hupe & Hill, 2012; Hill, 2013).

3.2.2 Policy-making models

While the stages model is often called a heuristic, useful for policy analysis but not good at describing how policy is actually made (Hill, 2013), many other models exist with higher (but varying) descriptive potential. In this section, four models that aim to explain how policy comes about are discussed: the rational model, the incremental model, the garbage can model and the mixed-scanning model. The analysis in this section is aimed at helping to answer level 3 research question 1 (Q1) of section 1.

The **rational (or rationalistic) model** depicts policy-making as a means-end relationship (Dror, 1964); the policy maker weighs the benefits of any decision with its expected costs. In this model, means and ends can be clearly distinguished and the policy maker has (or thinks to have) the cognitive capacities to estimate them both in an accurate way. The rational model shares the same assumptions with neoclassical economics, which is the framework within which the theory of Pigouvian (environmental) taxation was developed (see 3.3). Economic agents, including policy makers, act in a rational way according to their individual preferences in such a way that their utility is maximized. The policy maker has all the relevant information regarding costs and benefits that is needed to choose the optimal instrument in each situation. In this rational model, which assumes a first-best world with full information and rational policy makers without cognitive limitations, environmental taxation will come out as the optimal instrument in many cases.

The rational model is interesting to study as a theoretical ideal type, but it is heavily criticized for not being realistic (Hood, 1983; Tarter & Hoy, 1998; Howlett & Ramesh, 2003). According to Simon (1955), the policy maker does not *maximize* (benefits over costs), but his rationality is bounded, and his aim is to *satisfice*, or to aim for 'good enough'. Policy makers still seek rationality, but their rationality is bounded by limitations in appropriate and reliable information, cognitive capacities and decision-making time (Simon, 1955; Kahneman, 2003). Policy makers have no choice but to resort to unavoidable simplification (heuristics) to reduce complexity and keep matters manageable. In the **incremental model** policy decisions are the result of "bargaining and compromises among self-interested decision-makers" (Howlett & Ramesh, 2003, p. 141). Political feasibility and simplification are the dominant decision criteria in this model. Lindblom (1959) calls incremental decision-making 'the science of muddling' through. In his view, decision-making is a continuous process of taking new small and incremental steps based on limited comparisons with the incremental steps that were taken in the past. Only a few alternatives are considered, and only small number of potential impacts are evaluated. Policy-making is not so much aimed at long-term social targets but rather at alleviating present short-term imperfections (Lindblom, 1959). The incremental model of policy-making was equally criticized, for overestimating the lack of goal orientation and for being too conservative (Howlett & Ramesh, 2003). Its focus on the short run and on past policies neglects the possibility of societal innovation, and it demonstrates a disparaging and too passive view on public policy makers. Finally, the incremental model promotes short-sighted decisions that may have adverse impacts in the long run, which makes the model undesirable on a normative level (Lustick, 1980).

Like many other authors, Etzioni (1967) judged that the rational model is too megalomaniac and the incremental model is too modest. He developed the **mixed-scanning model**, which shows elements of the two earlier models. It is more flexible and combines high-order fundamental policy processes with more incremental ones. The level of detail of the 'scanning' of instrument options depends on the cost of the scanning, and on the cost of missing important variables due to a more superficial examination. Etzioni's view on policy-making is more realistic than the rationalistic approach, and more capable of capturing radically changing environments and introducing a strategic view than the incremental model. It also leaves options for 'smart' agency by policy makers, for example by choosing an option that may go counter the final objective in the short-run, but will serve the long-run strategic objective (Etzioni, 1967). The mixed-scanning model smooths off the sharp edges from the two other models which seem unrealistic on a descriptive level and undesirable on a normative level (*supra*).

The fourth policy-making model is the **garbage can model**, which is a radical policy model that denies any rationality, and that therefore can be considered as the opposite of the rational model of the previous section. Organizations are pictured as anarchical loose collections of ideas, which do not act according to preferences, but discover their preferences through action. Solutions look for problems instead of vice versa (Parsons, 1999). In this model, policy-making becomes a highly ad-hoc, irrational and unpredictable process (March et al., 1976). Solutions and problems are linked together ad random and coincidence will determine whether the link is justified or inappropriate (Parsons, 1999). The garbage can model is a chaotic model which is contradicted empirically by the observation that policy seems to solve environmental issues at some occasions very well. For example, the international agreement on the protection of the ozone layer[11] (Oberthür, 1999) and the sharp fall of dioxin emissions into the air in Flanders[12] resulting from stricter norms for industry. Many more examples demonstrate that mere coincidence is not a sufficient explanation for the fitting of problems and solutions.

Based on the above arguments, I conclude that the mixed-scanning model offers the most realistic view on policy-making. Therefore, the remainder of this PhD study will be based on the views of the mixed-scanning model regarding the role, the capacities and the agency of policy makers. This choice contributes to the answer of Q1 of the PhD study. The assumptions of the rational model, in which government agencies and officials have full information on the cost curves and the preferences of the target groups, are unrealistic. On the other hand, the incremental model has a derogatory representation of a policy maker with no capacities to look further ahead than the next day. Surely, policy makers' rationality is bounded, but in my view, they often go for more than just 'satisficing', and they will try to optimize, albeit within the limits of their bounded rationality.

[11] The 1985 'Vienna Convention for the Protection of the Ozone Layer', supplemented with the 1987 'Montreal Protocol on Substances that Deplete the Ozone Layer'.

[12] Statistics from http://milieurapport.be/nl/feitencijfers/milieuthemas/verspreiding-van-persistente-organische-polluenten-pops/emissie-van-pops-naar-lucht/emissie-van-dioxines-naar-lucht/, accessed 28 August 2017.

3.2.3 Taxonomies of policy instruments

In the past half a century, numerous attempts have been undertaken by scholars to develop typologies to classify policy instruments in a limited number of groups, depending on different criteria. Although more can be found, I see five main characteristics of policy instruments allowing to classify them:

1. Control model and regulatory mechanism;
2. Scale from voluntary to coercion;
3. General versus individual / specific;
4. Negative versus positive or constraining versus affirmative;
5. Substantive versus procedural.

The discussion on the various policy instrument taxonomies contributes to answering Q1 and Q2 of this dissertation (see section 1).

Before delving deeper into the five typologies, I want to mention a type of instrument that is not always included in existing typologies and that can be considered as an instrument 'sui generis'. Part of the literature on policy instruments starts from the question in what way governments can 'steer' actors into behaviour that contributes to reaching policy goals, such as the reduction of pollution. By taking this starting point, these studies overlook a rather obvious policy instrument, which is *direct provision* (Howlett & Ramesh, 2003). Direct provision means that a government performs a task itself instead of waiting for other actors to do it. Direct provision is part of what Hood (1983) calls 'organization', which is the stock of the land, buildings, equipment, and civil servants including their skills.

In many cases, substantial (financial) government investments are involved in direct provision, but it is not limited to the mere injection of funds. The most well-known example is infrastructure provision (e.g. roads and railways), but other means and activities, such as the deployment of personnel, the organization of education, healthcare or childcare, cleaning of public places, waste collection and other activities are part of the complex array of activities fitting under direct provision.[13]

Policy-making can be divided into direct provision and indirect regulation. The latter concept means that government uses policy instruments to try to steer societal actors into behaviour that contributes to the policy goals it has set.

All the taxonomies of policy instruments discussed in the next sections are of the indirect type. The most important classification basis presented is the control method, therefore it will be discussed more thoroughly than the other typologies.

Although the focus in this section is valid for any policy field, we will choose examples in the field of the environment, as that is the most relevant focus of the research.

Taxonomies based on the control method

Governments use policy instruments as tools to influence the behaviour of citizens, consumers, companies, organisations and lower government levels. To understand and classify policy instruments, it is useful to take a step back and look at ways with which people try to control other people's behaviour. Starting from theories from behavioural science, Lindblom (1977) puts forward three main 'control methods', or mechanisms that may influence behaviour: *authority,*

[13] Other common examples are the national security, the military, diplomatic relations, firefighting etc. (Howlett & Ramesh, 2003)

exchange and *persuasion*. Hood (1983) distinguishes the same three mechanisms, calling them authority, treasure and nodality.[14] Van der Doelen (1989) follows this typology, but he makes the link with policy instruments more explicit, thus proposing the typology of policy instruments that is still used in most text books on instrument theory today. Van der Doelen distinguishes three groups of policy instruments[15], which he calls the legal control model, the economic control model and the communicative control model. Vedung (1998) refers to the three control models behind the policy instruments with a metaphor: the *stick*, the *carrot and* the *sermon*.

Legal policy instruments are sometimes called authority-based instruments or command-and-control (CAC) instruments. The underlying control mechanism used by government is *coercion*, which is applied through issuing prescriptions and prohibitions to which target groups must comply (Howlett & Ramesh, 2003). The rules are enforced by government agencies and a whole system of penalties is available in case of non-compliance, including warnings, fines, temporary or final shut-down and imprisonment. Examples of authority-based instruments in environmental policy include emission standards, individual standards through environmental permits, a ban on burning waste in the garden and an obligation to sort household waste. In some cases, when the penalty system does not lead to the desired level of compliance, the government will make more direct interventions, often to prevent certain behaviour from a target group. For example, a road obstruction at the entrance of a natural park to prevent noise pollution from cars entering the national park. We do not regard this type of physical obstruction measures as part of the group of legal policy instruments, but we regard them as 'direct provision' (*infra*).

Economic policy instruments are also called financial instruments, market-based instruments, treasure-based instruments or chequebook government (Hood, 1983). The underlying control mechanism is *exchange*. Government installs a system of conditional flows of (mostly financial) resources from government to a private actor[16] or vice versa. Environmental taxes are clearly part of this group, along with subsidies and trading schemes such as emissions trading[17], which have gained a lot of ground in the past twenty years. The difference between marketable permits and (environmental) taxes is that the latter interfere with the price, while the (pollution) quantity is left to the market to determine, whereas in the former the quantity (the cap) is fixed by the regulator, while the market determines the price. In the end, however, they both put a price on pollution, which is why both instruments are often collectively referred to as 'pricing instruments' (Goulder & Parry, 2008). An environmental tax is sometimes called a 'price instrument', while ETS is referred to as a 'quantity instrument' (Baumol & Oates, 1988).
Other examples of economic policy instruments include deposit-refund schemes, feed-in tariffs and concessional loans. Note that our focus on taxes in this study is limited to regulatory taxes, meaning that taxes serving the two other main goals of taxation, revenue-raising and redistribution (Avi-Yonah, 2007), are not considered. The scope of the analysis of this PhD study is restricted to the field of environmental policy.

[14] Hood adds a fourth mechanism, organization, which is treated in the previous section. His fourfold model is known as the 'NATO schem', an acronym that stands for nodality, authority, treasure and organization.

[15] Other terms that can be found in literature as synonyms for 'groups of policy instruments' are 'control methods' 'regulatory models' and 'steering models' (as a translation of the Dutch term 'sturingsmodellen', although that last term seems to be used almost exclusively by Dutch-speaking scholars.

[16] Although the target group can also be a local government.

[17] Other terms we will use in this PhD study as synonyms include cap-and-trade systems, marketable permits, tradable allowances and tradable permits. When applied to carbon, a common term is carbon trading

Communicative policy instruments are also called information instruments, moral suasion or exhortation (Vedung, 1998). The underlying control mechanism are *information* and *persuasion*. Government tries to convince the target groups to behave in the desired way by informing that complying is in people's own interest, or by persuading them to do it as a moral duty. Information, communication and sensitising campaigns, labelling and voluntary agreements are examples of instruments in this model. Voluntary agreements are mostly the result of co-regulation, which we also classify in under the persuasion-based control method. In co-regulation, government and another actor, in most cases an industrial sector, large company or a local government, set targets and decide on instruments together, while leaving lots of freedom to the other actor to realize the – often voluntary – ambitions (Jordan et al., 2003). In practice, voluntary and information instruments are often used in policy mixes, which will be illustrated by an example on extended producer responsibility (EPR) in section 3.2.5. In some cases, the voluntary character of the action undertaken is bounded by a 'stick behind the door', legislation or (the threat of) a tax that will be implemented if no agreement is reached on the voluntary actions of compliance is lacking (Bachus & Franchois, 2007).
In the past 25 years, various taxonomies of policy instruments have been developed that follow this threefold scheme.

Other typologies

In this section, I will briefly touch upon the four remaining classification models or taxonomies for policy instruments. The first taxonomy distinguishes between positive, affirmative instruments making options more attractive, and negative or constraining instruments, which make some options less attractive (Hood, 1983; van der Doelen, 1989; Bressers, 1993). Examples of such opposite instruments include:

- For legal policy instruments: prescriptions and prohibitions versus legalization;
- For economic instruments: taxes versus subsidies;
- For communicative instruments: naming and faming versus naming and shaming.

This distinction is relevant for the topic of public support for policy instruments. Section 3.5 and **paper 4** will demonstrate that constraining instruments, such as regulatory taxation, suffer from public resistance, while positive instruments, such as subsidies, are much more acceptable to the public.

The second model classifies policy instruments based on the degree of government involvement. Howlett & Ramesh (2003) claim that this model was brought under the attention by political scientist as early as around 1940, when they argued government can only use two strategies to regulate, and that is in a coercive or in a non-coercive way. Linder and Peters use the term government intrusiveness instead of coercion (Linder & Peters, 1989), and Vedung (1998) calls it authoritative force. Several authors see a continuum scale, which positions policy instruments anywhere on the continuous scale of coercion from voluntary to compulsory (C. W. Anderson, 1977; Howlett & Ramesh, 2003)[18]. Note that both the control method typology and the positive/negative typology show similarities with this model, as the legal, economic, communicative, positive and negative instrument types can be positioned on the coercion axis. Legal instruments, whether obliging or forbidding, are highly coercive. Suasion instruments are all near the 'voluntary' end of the continuous coercion scale. Economic instruments can be on both ends on the scale: 'positive' economic instruments (subsidies) have a low score on

[18] In Vedung (1998)

coerciveness, while 'negative' economic instruments (taxes) can be regarded as highly coercive (see table 1).

The third typology is based on the distinction between general measures (for a large target group) and individual or specific measures (van der Doelen, 1989; Fenger & Klok, 2003). An example of a general measure is the ban on the sale of leaded petrol. A typical individual instrument is a permit with a specific emission standard for a specific air pollutant for a specific company.

The fourth typology distinguishes between substantive and procedural instruments (Howlett & Ramesh, 2003). The former are aimed directly at the target group and can further be classified, for instance into legal, economic and communicative instruments (*supra*). The latter refer to government provisions and tools that are not directly aimed at the target group, but contribute to the implementation or design of a programme from within government. Peters and van Nispen (1998) call these 'internal instruments', as opposed to 'external instruments' which are equivalent to substantive instruments. A parliamentary commission, monitoring, indicator development, accountability checks by an audit office, recruiting civil servants, regulatory impact assessment (RIA) or internal policy evaluations are examples of procedural (or internal) instruments. In this PhD study, attention will primarily be devoted to substantive instruments, since environmental taxation is a substantive instrument. However, **paper 2** is devoted to monitoring and indicator development, which belongs to the group of procedural instruments. As a corollary, level 2 research questions 1 and 3 of this PhD concern substantive instruments, while research question 2 (Q4 and Q5) is dedicated to procedural instruments (see section 1).

Overview

The presentation of existing typologies would be incomplete without providing an overview of the instruments fitting in them. In this section, we provide a summarizing table containing the most important environmental policy instruments. For readability, only two of the above presented typologies are integrated in the table. The first is the distinction based on the control method, between legal, economic and information instruments, who have different colour codes in the table. The second is the distinction between positive and negative or constraining instruments.
Explanatory notes are added below the table. An extended table containing subtypes of instruments and practical examples is provided in appendix 1.

Table 1. Overview of policy instruments

negative	positive
Environmental permit/ licence	Legalization
Performance standard	Low-regulation space
Emission standard	Labelling
Fuel efficiency standard	Awareness/information/ Dissuasion campaign
Energy efficiency standard	Sensitisation campaign
Quota	Voluntary agreement (co-regulation)
Ban or prohibition	Naming and faming
Prescription or obligation	Early warning system
National emission target	Voluntary code
Education attainment targets	Voluntary environmental standard
Technology standard	Recommendation
Litigation facilitation	Leading by example
Naming and shaming	Nudging[1]
Tax (charge, fee)	Subsidy
Tradable permits system[2]	Government guarantee/insurance
Removal of EHS	Tax expenditure
Liability scheme[3]	Tax compensation
Performance bond[4]	Feed-in tariff, green certificates scheme
White certificates scheme5	Concessional loans scheme
	Prize
Deposit-refund scheme	
Bonus-malus scheme	

Sources: compilation by the author based on Bennear and Stavins (2007), Fischer (2001), Perman et al. (2003), Sorrell et al. (2009), UNDESA (2012), UNEP (2004) and Steuwer (2013)

Colour codes:

= legal instrument;

= economic instrument;

= information instrument.

Notes:

1. Nudging is information provision aimed at behavioural change that is not trying to make people more aware, but instead focuses on changing the environment in which a consumer decision is made, which may influence the choices made by people's 'automatic minds'. For example, changing the default option for electricity supply to a family in a form to 'renewable energy'; only few people will take the effort to change the default option (Ölander & Thøgersen, 2014).
2. One of the subtypes of this instrument is the tradable performance standard scheme, with the government setting the benchmark, often based on (and more ambitious than) the average environmental performance of the products or companies. One example is the 1982 lead phase out programme in the US, which set an inter-refinery average (a 'cap') on importers and refineries; trading between underperforming and overperforming firms was allowed (Fischer, 2001).
3. Obligation to set-up a financial mechanism (compensation fund) in case of environmental damage or negligence in clean-up (in case of resource extraction), usually from the beginning of an activity.
4. The only difference between a performance bond and a liability scheme, is that the latter is a fund that is set-up by the company, while in the former case the company needs to pay the fee to the government, in which case it is comparable to a deposit-refund scheme. Stavins (2001) regards a performance bond as a type of insurance premium tax. Both instruments are regularly used in the context of mining activities (R. C. Anderson, 2002).
5. White certificates are certificates to certify energy savings by energy suppliers (Sorrell et al., 2009; Steuwer, 2013).

Deposit-refund schemes and bonus-malus schemes both have monetary streams in both directions, which is why they are labelled as mixed positive and negative instruments. In fact, a bonus-malus system can be considered as a combination of a tax and a subsidy, making it a policy mix (see 3.2.5). Other policy mixes have not been included in the table, as the combination list is sheer endless. Interesting examples of policy mixes include:

- ETR: a mix of an environmental tax and a reduction of other taxation, e.g. on labour;
- Earmarked taxes with revenues spent on environmental subsidies;
- An ETS with a price floor, which can be considered as a combination of a tax and an ETS;
- Any complex environmental policy instrument will be accompanied by an intensive information campaign by the government;
- Energy efficiency standards for new buildings combined with subsidies for additional environmental investments and with an energy efficiency certificate (labelling) scheme.
- A voluntary agreement between the government and an industrial sector combined with subsidies, but equally with the threat of a future tax if the sector underperforms.
- Tradable fishing quota in combination with zoning regulations, fish net standards and fish size limits (Bennear & Stavins, 2007).

The combination of the two typologies used in table 1 illustrates that legal instruments are mostly negative (coercive), while information or suasion instruments are often positive instruments. However, economic instruments cannot be uniformly classified on one side, as the positive and negative instruments in that category balance each other out.

3.2.4 Instrument choice

After explaining theoretical policy-making models and classification systems, we now turn to the question what makes governments choose a certain policy instrument in a given situation, both in theory and in practice.
According to Hood (1983), policy instruments are – ideally - chosen in a rational way, after due consideration of the most important alternatives and their merits and deficiencies. However, in section 3.2.2, the limitations of this rational model for describing how policy is actually made in practice were clearly indicated. This analysis led to the conclusion that bounded rationality needs to be taken into account when studying instrument choice in practice (Simon, 1955; Howlett & Ramesh, 2003).

The typical (rational) criteria that dominate the theoretical literature are effectiveness and efficiency (Hood, 1983). Legality, democracy, legitimacy, and fairness are also commonly named (Hood, 1983; Bemelmans-Videc, 1998), as are resources and constraints, both referring to (a lack of) money and information. Studies emphasizing these rational criteria are often made by scholars with an economic background, and Howlett and Ramesh (2003) call them 'technical models of instrument choice'. Political scientists tend to focus on 'political models', which extend the list of criteria with political factors, such as political support and opposition (see section 3.5) and past policy choices (McDonnell & Elmore, 1987). Political criteria are likely to be important when important lobby groups oppose to political proposals (Vandoninck et al., 2016). Furthermore, citizens are also voters, and according to the *median voter model*, the optimal election strategy for politicians is to take a policy position regarding government expenditure and taxation that represents the position of the median voter (Romer & Rosenthal, 1979). Although the median voter model has been criticized for unrealistic assumptions (Peters, 1991), the broader message that policy makers will take public opinion into account when deciding their instrument choice position, is accepted by many scholars (Luttbeg, 1981; Monroe, 1998; Caplan, 2001; Soroka, 2002; Burstein, 2003; Howlett & Ramesh, 2003).

Perman et al. (2003, p. 203) offer a list of nine instrument choice criteria from the perspective of environmental economics: cost-effectiveness, long-run effects, dynamic efficiency, ancillary benefits, equity, dependability, flexibility, costs under uncertainty and information requirements. In an empirical study focused on several policy departments of the Flemish government, Vandoninck et al. (2016) conclude that two instrument choice criteria are more important than others: the degree to which the instrument meets the targets and expectations put forward by the minister's office, and the support for the instrument by the interest groups that are concerned by the program. Other factors Vandoninck et al. (2016) found to play a role are time constraints, personal background of the officials involved[19], the European context and EU legal framework, the Belgian division of powers, the cost of the policy and the availability of budgets, administrative feasibility and history and earlier choices (path dependency). Many of these empirically observed criteria can be brought back to the importance of *policy subsystems* in the policy formulation phase. Howlett and Ramesh (2003, p. 53) define a policy subsystem as "*a space with actors from government and society where policy issues and their solutions are discussed and bargained*". Linder and Peters (1989) further refined the importance of subsystems by shaping a set of eight criteria that matter for instrument choice: resource intensiveness, targeting, political risk, constraints on state activity, policy style and political culture, organisational culture, context of the problem situation and the decision makers' subjective preferences.

[19] McDonnel and Elmore (1987) refer to the importance of the values of the policy makers.

Lastly, lobbying by interest groups is an important factor. According to Vandoninck et al. (2016), lobbying has much greater influence on instrument choice than formal advisory bodies. Kallbekken and Saelen (2011) specify that business and special interest groups have a lot of influence, and Olson (1965) adds that small interest groups with much at stake are most likely to influence policy choices. However, to date neither theoretical nor empirical studies have led to a consensus view on the importance of lobbying (Gullberg, 2008).

Two of the discussed instrument choice criteria receive a prominent position in this PhD study. Effectiveness and efficiency of environmental taxation are first treated in section 3.3.2 of this introductory chapter. They are also addressed in **paper 1** (Q2 and Q6 of section 1) where the efficiency of carbon taxation and carbon emissions trading in different situations is compared. Furthermore, in **paper 3** (Q7 of section 1), answering the efficiency question contributes significantly to the answer of the central research question on the potential of environmental taxation to foster sustainability transitions. Finally, in **paper 4** (Q3 and Q8 of section 1), (perceived) effectiveness appears as an important determinant of (lack of) public support for environmental taxation.
Finally, the political instrument choice criterion of public acceptability (Q8 of section 1) is treated in section 3.5 of this introductory chapter. It is also the central topic of **paper 4**.

3.2.5 The use of policy mixes

Although a discussion on all the merits and deficiencies of each of the instrument taxonomies exceeds the scope of this PhD study, a few general comments are appropriate. First, in most contexts, policy instruments and actions are not monolithic but will be used in a mix of different types of instruments (Bressers, 1993). Environmental problems are often complex, requiring combinations of instruments. Instrument and policy mixes have recently re-emerged as a prominent topic in environmental literature, which can be explained by the increasingly complex nature of environmental problems, such as climate change (Bennear & Stavins, 2007; Rogge & Reichardt, 2016). Moreover, government has more objectives than just protecting the environment, which also creates the need for policy mixes.

A policy mix is a broader term than an instrument mix, as it not only encompasses a mix of instruments, but also "includes the processes by which such instruments emerge and interact" (Rogge & Reichardt, 2016, p. 1621). The policy mix literature emphasizes that three additional criteria should be considered in the quest for the 'optimal' policy mix (Howlett & Rayner, 2013). First, multiple instruments should be consistent and aligned with each other, so they can reinforce rather than undermine each other. Second, policy goals should be coherent and not counteracting each other. Third, policy mixes should be congruent with government modes and styles, which refers to the fact that policy actors from different jurisdictions and with different styles and cultures will need to cooperate, which requires a high level of policy coordination.

A good example of a policy mix is an environmental tax reform (ETR), which consists of an increase of environmental taxation and a reduction of other taxes, such as on labour. In the case of earmarking, the tax is accompanied by a subsidy or environmental investments by government. Because of difficult public acceptability (see **paper 4** and Q8), an ETR should also be accompanied by a substantive information and sensitizing campaign. A second example of a policy mix involving environmental taxation is extended producer responsibility (EPR) as an instrument applied in Flanders for fostering eco-design and recycling. The EPR framework stems from EU legislation. In Flanders, this instrument is operationalized through a voluntary agreement between producers (and importers) and government, which is a non-coercive

communicative instrument. However, the voluntary character is limited, because the stick of legislation or a general levy is imminent if no agreement is reached between the two actors. The government actively uses this threat during the negotiations of the voluntary agreement (Bachus & Franchois, 2007). The policy mix also contains an economic instrument, as consumers pay a recycling charge when they buy the product. Moreover, most EPR applications are backed by legally enforced standards on a member state level (e.g. minimum recycling percentages for certain products or types of packaging). Finally, in the implementation phase, a lot of information and awareness-raising instruments are applied to persuade the consumer to dispose of the product in a correct way in the end-of-life phase.

The insights from the policy mix literature is important for the understanding of the optimal use of environmental taxation. In the quest for effective and efficient policies, policy coherence and consistency should be pursued both passively and actively. Actively, solutions for complex (environmental) problems should from the outset be thought of in a context of instrument and policy mixes, as one instrument is unlikely to be optimal in a realistic, second-best world (Howlett & Rio, 2015)(see section 3.3.2). And passively, when implementing new policies, a systematic screening should be done to make sure no other existing policies counteract the new one. A typical example is a tax on fossil fuels for environmental reasons, which co-exists with numerous tax credits and subsidies for the same fossil fuels for economic reasons.

Policy mixes occupy an important position throughout this dissertation. First, as stated above, environmental tax reform, is an example of a policy mix. Second, undesirable competitiveness effects of an ETR can be countered by combining the ETR in a policy mix with sector-specific repayments (see 3.3.3). Third, likewise, regressive effects of an ETR may be avoided by applying a 'smart' policy mix, e.g. by giving low-income families an additional tax credit (see 3.3.4). Fourth, in the instrument choice debate between a carbon tax and an ETS in the context of climate mitigation policy, a good choice may be a combination of the two, in the form of an ETS with a *price floor*, which now exists in the UK (**paper 1**). Fifth, since it measures only taxation, even the best indicators for measuring the greening of a tax system will be incomplete indicators for the environmental emphasis in policy-making overall (**paper 2**). An ideal indicator would be capable of measuring the environmental focus of all environmental policy instruments. The recently developed indicator *Effective Carbon Rate* (ECR) is the first indicator that measures the environmental emphasis of a policy mix, albeit limited to taxes and emissions trading.[20] Sixth, the potential of environmental taxation as an instrument to foster sustainability transitions seems to be highest when a tax is applied in a policy mix (**paper 3**). Seventh, public acceptability of an ETR is highest when it is implemented as a well-designed policy mix which includes subsidies for the poorest households and most of the tax revenues being recycled by environmental subsidies or environmental investments (earmarking, **paper 4**).

3.2.6 The usefulness of instrument taxonomies for the policy maker

One may wonder why policy makers should be aware of the fact that their instrument is classified in this or that group. Academics may be fond of taxonomies, but is it also useful for policy makers? Here, the link should be made between types and features of instruments on the one hand, and policy-relevant decision criteria used by policy makers, which are treated in

[20] Note that ECR is not treated in paper 2, as the indicator was developed by the OECD (2016) after online publication of the paper in *Ecological Indicators*.

section 3.2.4 of this introductory chapter. Knowledge on policy instrument groups can indeed be relevant for policy makers when opting for a certain instrument:

- Constraining (coercive) instruments such as taxes are likely to face opposition by the target groups and their lobbies, whether they are citizens or companies; positive instruments such as subsidies have more *support* (see 3.5 and **paper 4**).
- There is relative (academic) consensus that constraining economic instruments (taxes) are more *efficient* than affirmative economic instruments in many situations (Bachus, 2011).
- The two claims above combine into the conclusion that there is a trade-off between efficiency and acceptability, which may have a strong influence on instrument choice. This trade-off is analysed in **paper 4** and in the concluding chapter of this PhD study.
- Many empirical studies conclude that communicative instruments such as information and awareness raising campaigns suffer from low *effectiveness* compared to legal and economic instruments (Vedung, 1998; Syme et al., 2000). However, they may be useful as a complement to other (more constraining) instruments and in policy mixes (Gunningham & Sinclair, 1999).
- Some instruments are cheaper than others: subsidies put a large burden on government *resources*, while taxes raise revenue; most other instruments' costs are in between those two economic instruments. depending on the budget situation and debt burden of a country, this is important information.
- It is important for policy makers to know the regulatory costs and the administrative efficiency of policy instruments. For instance, in the choice between a carbon tax and an ETS in climate mitigation policy (**paper 1**), tradable permits require the creation of a new market, which is a very complex operation. Conversely, a carbon tax may be relatively easy to process, especially when it can build on the framework of existing taxes, such as energy taxes, and be coordinated by existing implementing tax agencies.

3.2.7 The importance of tax design

Despite the importance of the instrument choice question in discussions on the use of environmental taxation, it is important to acknowledge the importance of the design of the instrument, which can sometimes be more important than the instrument choice itself (see **paper 1**). A tax with a high tax rate may be more constraining than a prohibition that is hardly enforced.

Some relevant design elements for environmental taxes include the tax base, the tax rate, the timing of the implementation and the exemptions and rebates granted. In addition to design elements, accompanying measures, such as information and awareness campaigns or compensating measures such as subsidies can influence both the impact and the acceptability of the instrument chosen.

In **paper 1** we compare the instruments of a tax and an ETS for the case of Chinese climate mitigation policy. Although the instruments show some differences and the context can give rise to diverging instrument choice recommendations, the underlying mechanisms are comparable. The efficiency of the chosen instrument will depend on the price level that the instruments imposes on carbon emissions, and that price level will be determined by design choices. A tax with a very low tax rate will always be less effective than an auctioned ETS with a tight cap. Conversely, an ETS with grandfathered (=free) instead of auctioned allowances or with a conservative cap will be less effective than a tax with a significant tax level.

Besides effectiveness and efficiency, instrument design will also influence the acceptability of a chosen instrument. In **paper 4**, this topic is analysed in-depth. The initial low public support for an ETR can be improved by smart design choices and accompanying measures, such as:

- implementing an ETR instead of just an ET (policy mix);
- using earmarking as the main revenue recycling mechanism, supplemented with measures to relieve low-income families from a regressive impact;
- organizing an information and awareness campaign along with the ETR;
- make smart use of identified determinants of support, such as salience, the metric effect and the endowment effect (see 3.5).

Strong empirical evidence for the claim regarding the importance of instrument design is found in the EU ETS, which is a strong instrument in theory, but design choices lacking ambition have led to structural over-allocation of emission allowances, which entailed a trading price that is too low to have a strong mitigating effect (around €5/tonne CO_2 emission in spring 2017) (Ellerman & Buchner, 2008).

3.3 Environmental and Pigouvian taxation

3.3.1 Impact of environmental taxation: the theory of Pigouvian taxation

Taxes and levies as regulatory instruments to address environmental problems have been studied by economists for about one hundred years. Their use is linked to the existence of 'market failures', a term introduced by Bator (1958) to indicate a situation where the idealized market system is not capable of creating or maintaining a socially optimal or desirable situation. One example of such market failures is the existence of environmental externalities (Perman et al., 2003). Externalities are "*benefits or costs generated as an unintended by-product of an economic*[21] *activity that do not accrue to the parties involved in the activity and where no compensation takes place.*" (Owen, 2004, p. 129).
The definition shows that externalities can be positive or negative. However, in most cases, and in the context of our study, they will be undesired effects. Therefore, the terms externalities and external costs will be used interchangeably in this PhD dissertation.
Examples of environmental externalities include increased health cost because of air pollution, loss of biodiversity due to deforestation and climate change. The reason why environmental external costs are not accounted for is that most environmental goods, such a clean air, are public goods (Brookshire et al., 1982), and markets are not capable of providing public goods (Perman et al., 2003).

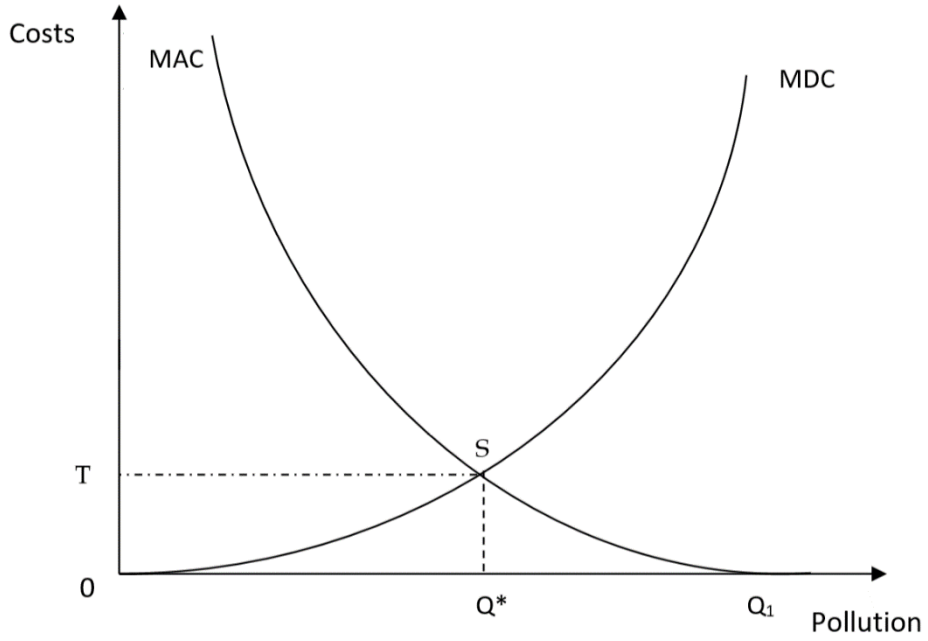
To resolve this market failure, government can create *property rights* for 'an unpolluted environment' or for 'clean air' and give them to citizens. Alternatively, the property rights can be vested in the polluter instead of the victim. The polluter then receives a 'license to pollute' a certain amount. Following the Coase theorem (Coase, 1960), this situation will lead to an equally efficient outcome as compared to victim property rights. However, from an equity point of view, the two solutions generate entirely different outcomes, as in the one case it is the polluter who pays, and in the other it is the victim (Perman et al., 2003). In theory, the polluter and the victims could bargain and agree on a compensation for the damage based on the victim's property rights

[21] Although non-economic activities can also create externalities, for example vandalism (negative) and using a bike for transportation instead of a car (positive).

(Coase, 1960). In practice, however, the large number of victims and polluters and the costs of bargaining often prevent an optimal outcome of private bargaining. In that case, government regulation, through the use of command-and-control instruments, economic instruments or suasion, is needed (Perman et al., 2003).

Pigou (1920) was the first academic to link environmental externalities to the instrument of taxation. He is therefore considered as the father of the 'Pigouvian taxation school'. The theory says that levies or taxes can be used to internalize external costs, which means that environmental problems, in the form of marginal damage costs, become part of the market model, and economic actors will take these internalities into account when making their consumption and investment decisions.

The optimal tax rate is found in the situation where it equals the marginal external cost of the pollution, which is also called the damage cost, as is shown in figure 3. If the tax is T, then the optimal level of pollution is Q*, because that level of pollution minimizes the total social cost (the area OSQ_1 in figure 3), which is the sum of the total damage costs (OSQ*) and the total abatement costs (Q^*SQ_1).



MAC = marginal abatement cost
MDC = marginal damage cost

Source: Farmer et al. (2001)

Figure 3. The optimal environmental tax level

3.3.2 Effectiveness and efficiency

According to Pigou's theory, in a first-best world without uncertainty, the regulatory tax is effective in reducing the pollution to the optimal level (see figure 3) if the optimal tax rate is applied (Bosquet, 2000; Bachus, 2011). Environmental taxes are also efficient instruments, which means that they tackle the pollution with minimal costs for society, hence with minimal welfare loss. Regulatory environmental taxes have high *static efficiency*, because an emission

tax equalizes the marginal abatement costs between polluters. Firms with lower marginal abatement costs can choose to cut back emissions more, while firms that face higher costs are likely to abate less and pay more taxes. This way, still in a first-best world without uncertainty, the overall environmental benefit is realized at minimal societal cost (OECD, 2001; Proost & Rousseau, 2007). Taxes are also *dynamically efficient* as they add a long run incentive to reduce pollution abatement costs, and for consumers to change their behaviour and avoid the tax (OECD, 2001; Verbruggen, 2007). Based on this first-best world analysis, the use of taxation in environmental policy has many benefits, which explains why it is used (Q3 of this PhD study, see section 1) and preferred over other policy instruments (Q2 of this PhD study) by policy makers in some cases.

However, the assumption of a first-best world, which implies that environmental externalities are the only market failure and that all markets are in the situation of perfect competition and full information, is hardly ever met. In welfare economics, the 'second-best theorem' implies that incomplete information, institutional or political constraints, technology spillovers or fiscal interactions may co-exist with environmental externalities. In this case, correcting just one of those market failures (e.g. by implementing an environmental tax) will not necessarily improve overall welfare (Perman et al., 2003). In such complex situations, a combination of multiple policy instruments, a policy mix (see 3.2.5), may yield the best results in terms of overall welfare (Bennear & Stavins, 2007). For example, in **paper 3** of this PhD, I explore the potential of environmental taxation in overcoming technological market failures. While the answer provided in the paper is cautiously positive, the impact on environmentally-friendly technology development is expected to be limited, and a combination of the tax with subsidies to promote environmental technology development may be the welfare-maximising policy mix.

In second-best situations, an in-depth analysis of the multiple deviations from the ideal-type situation is required to bring about the optimal equilibrium. More specifically, when there is uncertainty about the marginal abatement cost curves of polluting firms or about the monetary value of the marginal damage, the efficiency of environmental taxes, as compared to the more used command-and-control (CAC) instruments is not that straightforward. When the (absolute value of the) slope of the marginal abatement cost curve is greater than the slope of the marginal damage curve, taxes remain superior to CAC instruments (Weitzman, 1974). However, when the marginal abatement cost curve is less steep than the marginal damage curve, CAC instruments are to be preferred to taxes because the efficiency losses are smaller (Baumol & Oates, 1988; Perman et al., 2003).[22]

Moreover, in order for a tax to be effective, two conditions should be fulfilled. The first relates to the tax base, which should be as closely related to the emission itself or at least to the economic factor causing the emission (Oates, 1995; Edenhofer et al., 2010). A tax on the emissions can raise welfare up to twice as much as a tax on the output of the polluting industry (Carraro & Metcalf, 2001). However, this recommendation is often difficult to implement in practice, because of policy makers' limited awareness and because of the complexity, sometimes impossibility, of measuring actual emissions. In that case, government has no choice but to resort to taxation of proxies for emissions, such as final products (output), inputs (such as energy use), industrial processes, activities, waste generation, purchase, ownership, car registration, distance travelled or company profits. It should be noted that taxing proxies as opposed to emissions will inevitably entail efficiency losses, and it should therefore be restricted

[22] We refer to Perman et al. (2003, pp. 254-255) for an in-depth graphical treatment and explanation of this phenomenon.

to situations in which direct taxation of emissions or pollution is not possible or faces insurmountable obstacles (Perman et al., 2003). Applied to the case of pollution caused by transport, the ideal tax base would be the exact emissions of CO_2, NO_X, NMVOS, PM and noise, but as those emissions vary according to various factors and are very difficult to measure, several proxy-based taxes are in use. Taxation on gasoline and diesel purchase are good proxies, because they show a strong correlation with emissions, but taxes on the ownership of a car or car purchase are imperfect predictors for the emissions a car will produce. Consequently, these tax bases are less suitable if reducing car emissions is the objective.

The second condition for effective environmental taxation pertains to the elasticity of the demand of the taxed good. Ramsey (1927) found that the optimal tax rate is inversely proportional to the price elasticity of the tax base. In other words: in case of an inelastic demand, the tax rate should be higher. In that way the distortion created by the tax (the 'deadweight loss') is minimized (Bruvoll, 2009). Sandmo (1975) and Bruvoll (2009) added that the optimal tax rate for the externality-creating commodity is a weighted average of that computed under the Ramsey inverse elasticity rule and the Pigouvian marginal social damage. Ramsey's theory is important for policy makers, since it tells them on which commodities they can use (revenue-raising) taxes with the least distortions to the economy. Combining Pigou's and Ramsey's theories, one can conclude that the highest taxes should be levied on commodities with both high externalities and low price elasticity for demand. The best example of this kind of commodity is diesel and gasoline, which in practice indeed have much higher tax rates than any other comparable (energy) product.

Notwithstanding the stated conditions and assumptions, most studies conclude that economic instruments, including taxes and tradable permits, are more effective and efficient instruments in environmental policy than standards and individual permits in most situations (Hahn & Stavins, 1992; Perman et al., 2003)[23]. Within the group of economic instruments, there is more debate about the comparative evaluation of taxes and tradable permits. In theory, with optimal design and fully auctioned permits, the two instruments should have the same impact (Newell & Pizer, 2003; Hepburn, 2006; Edenhofer et al., 2010). However, when uncertainty is introduced, the discussions get less straightforward. According to Weitzman (1974), a tax is more efficient if the marginal benefit curve of the environmental good is flatter than the marginal cost curve and vice versa (Keohane et al., 1997). In this PhD study, we aim at contributing to the discussion on the benefits and weaknesses of a carbon tax and an emissions trading scheme as a climate change mitigation instrument. A more detailed analysis of this comparison is carried out in **paper 1**. This analysis will contribute to answering this PhD study's research questions Q2 and Q3 (see section 1).

3.3.3 Side effects: competitiveness

The potential negative impact of environmental taxation on the (international) competitiveness of firms is a highly-debated phenomenon, both in the policy world and among academics. An environmental tax may affect the firm's costs, and hence the price at which it can sell its output on the international market (S. Smith, 2003). Competitiveness concerns are most serious in energy-intensive sectors with significant international trade, where the 'leakage' may be

[23] This conclusion is only valid for the constraining economic instruments (taxes and tradable permits). Subsidies suffer from several inefficiencies which makes them much less effective and efficient than (properly designed) taxes and permit trading (Bachus, 2011).

strongest (OECD, 2001), meaning that firms shift their production to countries with lower environmental taxation. As the threat of delocalisation, whether legitimate or not, of industrial companies is a cause for concern for political governments, it offers an important explanation for the underuse of taxation in environmental taxation up to now (Q3 of this PhD study) (Oh & Svendsen, 2015).

Revenue recycling through reduction of other distortionary taxation such as labour taxation mitigates a negative competitiveness impact (Bachus, 2011). According to some studies, the overall impact of the reform on GDP and (especially) employment is even positive. In that case, a so-called 'double dividend' arises (Pierce, 1991): the reform creates a win-win situation as a dividend is realized on both the environmental and the employment side. From a policy perspective, this sounds like a miracle solution. However, in the academic world, there is a lot of scepticism regarding the existence of the double dividend. Some authors reject the double dividend thesis based on theoretical arguments. They claim an ETR entails two effects: a **revenue recycling effect** and a **tax interaction effect** (Goulder et al., 1996). The first is the welfare gain resulting from the reduction in labour or other distortionary taxes, while the latter refers to the fact that the environmental tax increases consumption prices, thus lowering the purchasing power and the real household wages. The two effects have an opposite effect on employment. The question which one of the two effects is the largest determines whether a double dividend is within reach or not. Some scholars conclude that the tax interaction effect dominates the revenue recycling effect, thus rejecting the double dividend thesis (Bovenberg & de Mooij, 1994), while other come to opposite conclusions. Various empirical studies have concluded that a revenue-neutral ETR with revenues going to labour or capital tax reduction has a positive impact on employment and no or only a slight (positive or negative) impact on a country's GDP (Denis & Koopman, 1995; Carraro et al., 1996; Ekins & Speck, 1999; OECD, 2001; Bossier et al., 2002; M.S. Andersen et al., 2007; Saveyn et al., 2011). However, some sectors may face some output losses. The cement, ferrous metals and energy producing sectors are named most often (Bossier & Vanhorebeek, 2003; M.S. Andersen et al., 2007).

Bovenberg and Goulder (Bovenberg & Goulder, 2001) have modelled a solution for this remaining efficiency loss: exempting key industries for just a small fraction of their emissions from the tax would mitigate the losses in those industries to such a level that the environmental benefit can be realized without any loss of profits in key industries. This type of tax is also called a threshold tax. Besides reducing negative competitiveness impacts, a threshold tax may also have the benefit of being more acceptable to the public than a 'pure' environmental tax (**see paper 4**) (Pezzey, 2006).

3.3.4 Side effects: distributional impact[24]

As it is their aim to change consumption and production patterns, many environmental taxes inevitably face the risk of being income regressive (Kriström, 2006; Blobel et al., 2011), which means that "poorer households pay a disproportionate share of their income in these taxes relative to richer households"(OECD, 2001). Various empirical studies confirm this thesis (Brännlund & Nordström, 2004; Bork, 2006). This is clearly an undesired side effect of some environmental taxes.

[24] Alternative terms to refer to this problem include equity, tax incidence, distributional effects, regressive vs. progressive impact, social impact.

In case of a comprehensive ETR, the revenue recycling creates both risks and opportunities for equity. The revenue recycling by reducing taxes on labour will reduce unemployment which arguably has a positive effect on combating poverty. However, this positive effect is probably more than fully offset by the fact that lowering labour taxes tends to favour the poor less because they are less represented in the workforce than average (Bork, 2006).

Distributional impacts of ETR with a reduction of labour taxation depend on *whose* labour taxes are reduced. Most academics focus on the option of a reduction of the *employers'* social security contributions as they allegedly maximize the economy's welfare and employment gains (Bachus, 2010). However, governments wishing to put more emphasis on avoiding regressive impacts may consider to divide the tax cut between employers' and employees' contributions, which may slightly lower overall welfare, but at the same time entail lower regressivity (Blobel et al., 2011).[25] This 50-50 division was chosen in the 1999 to 2003 ETR in Germany (Bach et al., 2002).

Additional measures can be taken to improve the equity impact of an ETR. A part of the revenue recycled may be reserved for moderating regressive effects. *Compensation* measures are in this context to be preferred over *mitigation* measures, meaning that compensations that keep the environmental tax intact (such as higher social benefits or lump-sum repayment for low-income households) are less distorting than exempting low-income families from the environmental tax, as this option erodes the environmental impact and the concomitant welfare gains (OECD, 2001).
According to Ekins et al. (2011), one of the most equitable ways to recycle the revenues in an ETR is an equal lump-sum payment, or eco-bonus, to all households, as the lump-sum is a higher percentage of income for the financially deprived households. The downside of this recycling option is obviously that the employment gains from lump sum payments are much lower than from labour tax cuts. This issue clearly illustrates the trade-off between the efficiency and the distributional impacts of an ETR (Ian W. H. Parry & Williams, 2010).
It should be noted that 'regressivity' is a relative term. In the modelling work of Ekins et al. (2011) all households gain from an ETR, but if low-income households gain less than others, we still label the impact as regressive. In this case, it does not necessarily lead to policy advice against the ETR. Finally, we note that an ETR that is (perceived to be) regressive may suffer from lower public support (see **paper 4**).

3.4 Sustainability transitions

In the past twenty years, an increasing number of academics have started to describe some of the contemporary environmental problems as long-term and persistent, and associate them with industrialized societal systems (Geels et al., 2004; Lenton et al., 2008; Foxon et al., 2009; Avelino et al., 2016). Natural resources depletion, including energy, and climate change are two examples of such long-run problems. According to Loorbach (2007), current institutions and organisations are not equipped to solve such complex problems, and a systemic approach – as an alternative to the dominant incremental approach - is needed to deal with those problems in the long run. In other words, a *sustainability transition* is needed.

[25] Another reason that this option may appeal to governments is that it increases the chances of an ETR receiving support from the trade unions, which is relatively important in some countries. For example, in the 2003 ETR in Germany, the labour tax cut was split 50-50 between employers' and employees' contributions (Bachus, 2010). In Sweden, income taxation was reduced along with employers' social contributions (Blobel et al., 2011).

Transition theory has its roots in many other literature strands: it contains elements from science & technology studies, evolutionary economics, structuration theory and neo-institutional theory (Grin et al., 2010), system approaches, complexity theory and co-evolution theory (Geels, 2005). The integration of this multitude of approaches can be considered to have developed into a new theoretical body, called the school of sustainability transitions.

In this PhD study, two theoretical models from transitions thinking, the multi-level perspective (MLP) and the multi-phase perspective (MPP), are used and combined (in **paper 3**) with the theory of environmental taxation to provide an answer to Q7 of this PhD study. The *multi-level perspective* (MLP) distinguishes between three levels (Geels, 2004; Verbong & Geels, 2007). At the macro level, the *landscape* represents the external environment of the system, which influences the socio-technical system but which is very difficult to change (Markard & Truffer, 2008). At the meso level, the *regime*, which can be a dominant technology, institution, policy, practice or culture, is the dominant form of functioning in the socio-technical system (Avelino & Rotmans, 2009). At the micro level, *niches* present alternative (sustainable) technologies, institutions, policies, practices or cultures that may disrupt the functioning of the socio-technical system. Niches can eventually overtake the role of the regime and install a new dynamic balance in the socio-technical system (Kemp & Loorbach, 2006; Loorbach & Wijsman, 2013).

An important question within the sustainability transition literature is the question whether it is possible to find policies or steering mechanisms to direct transitions in a (more) sustainable direction. Most transitions scholars see an active role for government, but not as the top-down commander who can steer at will using its instrument toolbox (Paredis, 2013). Rather, government is seen as just one group of actors (Geels et al., 2004), who are part of the regime. Government actors can exert influence on the functioning of the socio-technical system as they often are at the helm of various regime functions (A. Smith et al., 2005). Rotmans (2003) introduced the model of *transition management*, a term that clearly suggests that it is possible to manage, and steer, a transition. Loorbach (2007) partly agrees, claiming that it is possible to at least influence a transition using insights from transition theory. Other authors are not so affirmative: Shove and Walker (2007), for example, warn against a too simplistic view on the politics related to transitions governance, and against overlooking the various interests at play. In this PhD study, this question will be discussed in more detail, with a focus on the structure (mainly technology) and practices elements of societal systems. In this PhD study (**paper 3**), we explore if environmental taxation can play a role and contribute to a sustainability transition. We use the technology life cycle model (TLC) and compare its S-curve with the S-curve from transition theory. The aim is to investigate in which phase of a transitions an environmental tax can make a contribution. On the side of practices, Shove and Walker (2010) are rather sceptical about the potential of common governance approaches and instruments for changing practices. Shove (2012) claims that the impact of government interventions is unstable and unpredictable. Impact is only possible by trying to change the conditions for (un)sustainable practices. Public authorities can bring about strategically important changes that may influence the reproduction of practices (A. Smith et al., 2005). While pursuing this, policy makers may use similar instruments to the ones in place today (Shove, 2012), which include regulatory taxation, albeit selectively.

Most studies on the governance of sustainability transitions focus on the development and upscaling of niches. Consequently, they largely ignore that the destabilization of incumbent regimes can equally be a valuable strategy, because this could speed up the upscaling of niche technologies (Kivimaa & Kern, 2016). In this PhD research (**paper 3**), we explore the potential of environmental taxation for fostering sustainability transitions (Q7 of section 1). The MLP and

the MPP will be used to explore the impact of environmental taxes on the structure (technology) and the practices and cultures of socio-technical systems. The impact on practices and cultures will be discussed using the social practices theory, which argues for a contextual approach to consumption, giving equal weight to the role of agency and to the social structure in which people act (Spaargaren, 2003). Finally, the impact of the use of policy mixes containing environmental taxation will be explored, which will link this paper with section 3.2.5 of the introduction.
Paper 3 will offer a critical view on some of the presented theories. First, it will challenge the deterministic view in transition literature on the (limited) role of public policy. We consider the role of policy and policy instruments to be underexplored. Second, we will not take the idea for granted that systems change can only come from the bottom-up dynamic of developing niches, as many transitions scholars explicitly or implicitly claim. We will complement this view by adding a strong focus on regime destabilization. Third, we will challenge the basic assumptions of neo-classical economics, including rational choice theory and the assumption that preferences are fixed.

3.5 Public support for environmental taxation

In section 3.2.4 we analysed on what basis policy makers choose which instrument to deploy for tackling policy challenges. We saw that political feasibility is important, both in theory and in practice (McDonnell & Elmore, 1987). While the concept of political feasibility is debated to greater depth in political theory and political philosophy literature (Gilabert & Lawford-Smith, 2012), it is also discussed in environmental policy-oriented literature. The two most important factors related to political feasibility in that literature are the support of industry pressure groups and public support (Räikkä, 1998).

Public acceptability is an important factor explaining the relative underutilisation of regulatory taxation for environmental purposes. The policy maker is likely to consider the acceptability of a policy instrument for voters (Peters, 1991; McAusland, 2003; List & Sturm, 2006). According to the *median voter theorem*, the optimal election strategy for politicians is to take a policy position regarding government expenditure and taxation that represents the position of the median voter (Romer & Rosenthal, 1979). Although the median voter model has been criticized for its unrealistic assumptions (Peters, 1991), there is no doubt that there is an important link between public acceptability and policy instrument choice.

The question how support for certain policy instruments or decisions is explained or determined is a complex matter. The environment is a societal (and policy) issue that has gained a lot of support throughout the last decades. People today are much more aware of and concerned about environmental problems. (Blake, 1999). The increased awareness opens the door for more stringent policy choices to tackle environmental problems. However, it appears that support for the *objective* is not a guarantee for support for the *instrument*. According to Hood (1983) "*the instrument commonly is far more contentious than the aim itself*". And the instrument of environmental taxation does suffer from a severe lack of popularity. One possible explanation is linked to one of the taxonomies of policy instruments we presented in section 3.2.3: according to Cherry et al. (2012) and Baron and Jurney (1993) people are more inclined to object to a policy instrument when they view it as more coercive. McCaffery and Baron (2003a) call this phenomenon 'penalty aversion'. Subsidies are a voluntary instrument, whereas taxation and command-and-control instruments "restrict people's freedom of choice and force people to change their own behavior" (Steg et al., 2006, p. 94). To Stern et al. (1993), this coerciveness aversion is a simple expression of the fact that people act out of self-interest.

Hard regulations provoke a negative psychological reaction and people see the coercive policies as a loss of freedom (Attari et al., 2009, p. 1702).

However, penalty aversion can only partly explain the poor acceptance of regulatory taxation. Apparently, taxes face even stronger opposition than that other coercive instrument, command-and-control. According to Clinch et al. (2006, p. 968), taxes have "particularly negative connotations". Nordhaus (2007) even claims that for many people a tax is "almost a four letter word". One explanation for this low acceptance of taxation is probably linked with the long history of the use of taxation, and the fact that it has been used so often for revenue raising, one of the three goals of taxation (see introduction) (Avi-Yonah, 2007). The lack of support seems to be an even bigger problem for environmental taxes than for taxes in general: people tend to dislike environmental taxes even more than other taxes (Green Fiscal Commission 2009). A simple and rational explanation for this phenomenon is self-interest: environmental taxes generally increase the prices of certain goods or services, and people do not like to see reductions in their purchasing power (Stern et al., 1993). However, this rational explanation seems to be insufficient, as sometimes people even object to a tax reform that is to their own benefit (Kallbekken et al., 2010). This phenomenon is called tax aversion (Sussman & Olivola, 2011).

Other phenomena explaining low acceptability of environmental taxes are offered by the field of behavioural economics. This field builds further on the assumption of bounded rationality, as stated by Simon (1955). In section 3.2.2, bounded rationality was found to play a role in policy decisions, but consumers too aim to *satisfice*, or aim for 'good enough', instead of aiming to *optimize*. The consumer still seeks rationality, but his or her rationality is bounded because of a lack of appropriate and reliable information, limited cognitive capacities and limited decision-making time (Simon, 1955; Kahneman, 2003). Bounded rationality makes citizens resort to unavoidable simplification and heuristics to reduce complexity and keep matters manageable. Bounded rationality untangles various biases that help to explain why support for environmental taxation and environmental tax reform is so limited. These biases, including the fiscal illusion, the role of salience, the isolation effect, the aggregation effect, wishful thinking, the endowment effect, the metric effect and the role of framing will be examined in **paper 4** of this PhD study, which aims to answer research question Q8 of this PhD study (see section 1). Additionally, the paper will examine which determinants or predictors can be found for (lack of) support for ET and ETR. Some of the potential determinants are people's education level, income, owning a car, trust in government, environmental concern, political ideology, perceived effectiveness and regressivity of the ETR, specificity of the question, labelling and framing, earmarking and information provision.

In addition to the state-of-the-art of the literature, **paper 4** will provide empirical evidence explaining low support for environmental taxation and environmental tax reform. The empirical evidence will be based on a large-scale quantitative survey held in Flanders. Ordinary least square and other types of regression analysis will enable us to estimate the strength of the determinants and the support for different ways of revenue recycling in case of an ETR.

4 | Methodology and empirical theory testing

In this section, a horizontal overview of the methodologies and the empirical theory testing used in the PhD study is presented. Three methodologies are highlighted: policy evaluation methodologies, indicator development (including index theory) and statistical methods.

4.1 Policy evaluation methodologies

This PhD contains exercises of policy evaluation in each of the four publications. The comparison between environmental taxes and emissions trading in **paper 1** can be considered as an evaluation using evaluation criteria such as effectiveness, efficiency, competitiveness impact, distributional impact and equity and political feasibility. This type of evaluation contains elements of both theoretical and empirical evaluation.
In **paper 2** I will go a step further, by designing a new evaluation framework, aimed at evaluating existing indicators for measuring the greening of a tax system. In this paper, evaluation is used as a way to develop state-of-the-art indicators for measuring the theoretical concept of the greening of a tax system. The evaluation criteria used in this exercise are content validity, comprehensiveness, data availability, temporal comparability, international comparability and availability of aggregation options. I make a comparative evaluation of four types of indicators by using an ordinal scale. The evaluation gives rise to conclusions on the preferred instruments for measuring the greening of the tax system.
Paper 3 is a theoretical evaluation of the applicability of sustainability transition theory to environmental taxation, or – in other words – an exploration of the potential of environmental taxation as a policy instrument to contribute to long-term sustainability transitions. Insights from environmental economics, transitions thinking, the multi-level perspective and the social practices approach are combined, leading to the comprehensive conclusion on the potential of taxation to contribute to long-term sustainability transitions.
In **paper 4** we carry out an empirical evaluation of the public support for an environmental tax reform. The level of public support for environmental taxation is not only an interesting academic empirical study object as such; it is also an important explanatory factor for the use of taxation as a regulatory policy instrument. In that perspective, the evaluation criterion of public support will take an important position in most policy advising and evaluation studies on environmental taxation.

4.2 Indicator development and index theory

The main goal of **paper 2** is to answer research questions Q3 and Q4 of this PhD study (see section 1), regarding the evaluation of existing indicators the development of alternative indicators for measuring the greening of a tax system. After concluding that the dominantly used revenue-raising indicators perform poorly on validity criteria, I develop a new type of indicator, which is based on tax levels instead of government revenues. As the aim of the indicators is the use on an aggregated (national) level, it is necessary to give it the shape of an *index number*. A composite or aggregate index number 'aggregates detailed information on prices and quantities into scalar measures of price and quantity levels or their growth' (Diewert, 2008). The indicator that is developed in **paper 2** is of the type of the Consumer Price Index (CPI), which is used to measure inflation. While the CPI uses variable baskets of goods and services to follow the

evolution of their prices, my 'National Environmental Taxation Index' uses variable baskets of environmentally related taxes to monitor the evolution of its tax rates.
For maximal validity, a weighted index number is preferred over an unweighted one (ILO et al., 2004). In the past century, a vast body of literature has developed on index numbers and the weighting issue. The most general - and most commonly used - type of index number is the Lowe index, which can use any type of quantity weight from any period. That feature is also its advantage, as the evolution of tax rates can be measured using the tax revenues from one, two or more years in the past. However, a more valid index number would be the one that uses the revenues from the current year. That type of index number is called the 'Laspeyres' index number, which is more valid but has the drawback that its weights can in most cases only be used two years in the past, which is a major deficiency for policy-making. In sum, the Laspeyres index is the most valid one, but also the most difficult in terms of data gathering. The Lowe index has a slightly lower validity, but is more pragmatic in terms of data gathering.

Below the formula for both types of index numbers is shown.

Lowe: $$P_{Lo} \equiv \frac{\sum_{i=1}^{n} p_i^t q_i}{\sum_{i=1}^{n} p_i^0 q_i}$$ Laspeyres: $$P_L = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$$

In **paper 2** I develop a new type of indicator using both these index numbers, putting forward the hypothesis that the two approaches will differ only slightly in practice. If that hypothesis is confirmed, the Lowe index can be used as a good proxy for the Laspeyres index.

In the search for indicators for measuring the greening of a tax system, we distinguish between four types of indicators: revenue-based indicators, single tax rates, aggregate tax-rate based indicators and the implicit tax rate on energy. Each of these types of indicators will be analysed, and a conclusion will be drawn on which is/are the best for use by policy makers.

4.3 Statistical methodologies

This PhD study contains an empirical study on public support for environmental taxation (**paper 4**), which aims at answering Q8 of this PhD study. We carried out a survey in Flanders, aiming to reveal the explanatory factors of public acceptability of environmental taxation and environmental tax reform. Ordinary least square regression and an ordinal logit model were applied to identify the determinants for public support and willingness-to-pay for environmental taxation. Additionally, the following statistical analysis tools are used in the paper (Warner, 2008):

- the Wilcoxon Rank test, which is used to compare two sets of scores that come from the same participants;
- the Bonferonni post hoc test, which makes pairwise comparisons of averages.

4.4 Empirical theory testing

Many scientific theories seem to hold water intuitively, but it is important to challenge and test them by adding perspectives from empirical research (Roth & Van Der Velde, 1991). At least on three occasions we put the theory to the empirical test. In **paper 1** the existing theory on the features and the explaining factors for success or failure of the policy instruments of taxes and emissions trading is applied to the case of China. This empirical analysis contributes to insights on the features and success factors of the policy instrument of taxation applied in the field of the environment. Relevant observations include the limited government capacity in China to create, regulate and monitor a new market of emissions trading and the comparatively low risk in China for a carbon tax to be regressive if revenue recycling is included in the policy package.
In **paper 2** the theories on indicator development and index numbers are applied to Flemish data. The data are obtained from a 2013 study on the greening of the tax system in Flanders (Bachus, 2013). The database allowed for comparison of the *chained Lowe and Laspeyres indexes for Flemish environmentally related taxes* we developed for measuring the greening of the tax system.

Paper 4 contains an important empirical part. A survey is carried out to test some of the hypotheses put forward in the theoretical part of the paper. The survey allows us to draw conclusions on public support for environmental tax reform, the determinants explaining the degree of support, the conditions to which support is (not) obtained, the importance of the specificity of the instrument, and the importance of the chosen method of tax revenue recycling (ETR).

5 | Overview of the four PhD papers

In section 1, the link between my research questions and the four academic publications that will constitute the backbone of my PhD thesis was explained. In this section, an abstract is provided for each of these four publications.

5.1 Paper 1: Cap or tax? Exploring the potential for a carbon tax or emissions trading in China

Full reference:

Bachus Kris and Cao Jing (2013), Cap or tax? Exploring the Potential for a Carbon Tax or Emissions Trading in China, in: Bruyninckx Hans, Qi Ye, Nguyen Quan Thuan and Belis David, *EU-Asia Climate Relations: Evidence from China and Vietnam as Key Emerging Economies*, Edward Elgar, Cheltenham.

Abstract:

In this paper, we discuss the choice for a carbon tax versus an emissions trading scheme as the instrument for climate change mitigation policy for China. The central research question of this paper is “Given its policy context and comparing with the EU, is a carbon tax or an emissions trading scheme the best climate mitigation policy instrument for China?”

We first set out a theoretical discussion on the instrument choice question. The paper zooms in on market-based instruments and makes a comparative evaluation of the economic instruments of a carbon tax and an emissions trading scheme. Both instruments put a price on carbon, a tax does this by fixing the price, leaving the resulting quantity emitted undetermined. Emissions trading does exactly the opposite: the quantity is fixed by the policymaker and the price is left to be determined by the market.

Subsequently, we describe China's current domestic climate policies and measures adopted by China's government for GHG emissions reductions. We assess the arguments for both instrument groups based on China's particular situation and provide a number of design recommendations, before drawing the main conclusions for the Chinese case. The paper concludes that a carbon tax has a slight edge on an emissions trading scheme, but the outcome depends on many factors outside of the choice of the policy instrument. An emissions trading scheme can only achieve its theoretical potential if design elements, such as the emissions cap and the ratio between grandfathered and auctioned permits, are chosen well. Furthermore, the critical conditions of a sound administration, reliable emissions data and a well-functioning market, need to be fulfilled. In the near future, those conditions will be difficult to fulfil in China.

A good solution for China may be the use of a hybrid instrument, combining emissions trading with features of a tax. In practical terms, a floor price and a ceiling price may be added to the scheme, protecting against both undesirably high and low permit prices.

5.2 Paper 2: How to tell green from grey? Towards a methodological framework for evaluating the greening of national tax systems

Full reference:

Bachus, Kris (2016), How to tell green from grey? Towards a methodological framework for evaluating the greening of national tax systems, *Ecological Indicators*, 71: 229-238, DOI https://doi.org/10.1016/j.ecolind.2016.04.009 (2016 IF: 3,898).

Abstract:

In this paper, we evaluate four types of indicators that can be used for measuring the greening of a tax system: revenue-based indicators, single tax rates, aggregate tax-rate based indicators and the implicit tax rate on energy. The central research question is "How can we evaluate different types of indicators for measuring the greening of a tax system, and which alternative aggregate indicator(s) can we develop to improve the existing indicator set?"

We develop an evaluation framework, introducing two principal evaluation criteria: content validity and comprehensiveness, and four statistical criteria: data availability, comparison over time, international comparability and ease of aggregation. Additional analysis regarding the issue of weighting is carried out for the aggregate tax-rate based indicator, by using insights from index theory to develop a new aggregate indicator for measuring the greening of the tax system. A Lowe and Laspeyres index are selected to test the hypothesis that they are both suitable for the monitoring purposes I have designed them for.
The theoretical and methodological evaluation is supplemented and validated empirically using data on the Belgian and the Flemish tax system. Finally, conclusions are drawn with regard to the strengths and the weaknesses of the four types of indicators and recommendations are made for further research.

5.3 Paper 3: The use of regulatory taxation as a policy instrument for sustainability transitions: old wine in new bottles or unexplored potential?

Full reference:

Bachus, Kris & Vanswijgenhoven, Frederic (2017), The use of regulatory taxation as a policy instrument for sustainability transitions: old wine in new bottles or unexplored potential?, *Journal of Environmental Planning and Management*, DOI http://dx.doi.org/10.1080/09640568.2017.1358155 (2016 Impact Factor: 1.560).

Abstract:

This paper examines the role environmental taxation can play in fostering sustainability transitions. The central research question is "What is the potential of environmental taxation as a policy instrument for fostering sustainability transitions?"
This article combines the literature strands on environmental taxation and on sustainability transitions from a theoretical perspective. We make use of the multi-level perspective (MLP) and the multi-phase perspective (MPP) as heuristic frameworks to examine the potential effects of regulatory taxes on different levels and in different phases of a transition. The potential of regulatory taxes for accelerating the diffusion process of technological innovation is explored by combining technology life cycle theories with the multi-phase model from transition theory.
The focus of the theoretical exploration subsequently shifts from technology to practices, by focusing on the social practices model. We look for answers to the question whether social practices can be changed with policy instruments; this discussion also touches on the issue of (bounded) rationality in policy-making (see section 3.2.2 of this introductory chapter).
Furthermore, the robustness of the theoretical implications is tested through an exploratory analysis of the Belgian energy system as a case study. Finally, the paper concludes that the potential of environmental taxation primarily lies in the acceleration and the maturity phases of the multi-phase model, and a policy mix will be needed for enhancing the transition in the other phases.

5.4 Paper 4: "I'll accept it if you earmark it": towards an improved understanding of the acceptability of environmental tax reform

Full reference:

Bachus Kris, Verhofstadt Elsy & Van Ootegem Luc, I'll accept it if you earmark it": towards an improved understanding of the acceptability of environmental tax reform, in review, submitted to Ecological Economics on 19/04/2017 (2016 IF: 2,965).

Abstract:

The central research question of this paper is "what are the factors determining public support for environmental tax reform and how can this support be increased?"
The first aim of this paper is to review the theoretical and empirical state of the art on public support and willingness to pay for environmental taxation. Starting from the discussions on instrument choice and policy-making models (see 3.2.1 and 3.2.3), we subsequently shift the focus specifically to the tax instrument, which suffers a lot from a lack of popularity with the public. The phenomenon of tax aversion explains why some people object to an environmental tax reform, even if it is in their own benefit. The factors determining and explaining the support

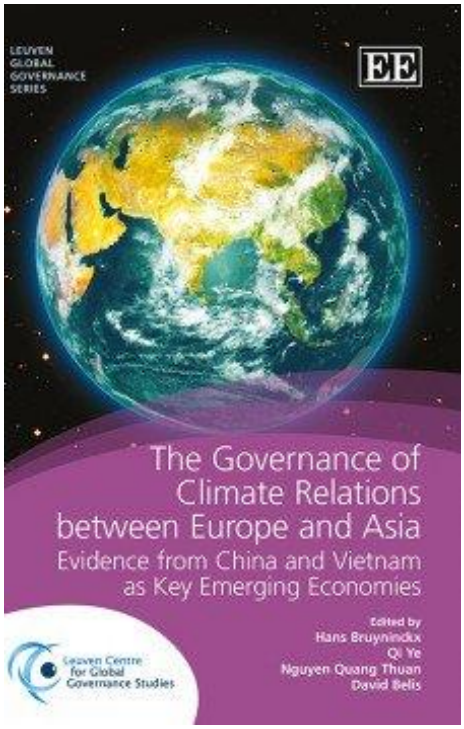
for environmental tax reforms are discussed, and we explore strategies that governments can follow to increase support for certain tax reforms.
The second aim of the paper is to test a number of theoretical and empirical conclusions put forward by previous studies, by analysing the results of an extensive survey (the LEVO survey) we carried out in Flanders, Belgium. One example of a hypothesis is the fact that people tend to object environmental taxation more if it is described as a specific and concrete measure, compared to a more general presentation.
The paper draws conclusions on the most important parameters explaining support for green tax reforms, and develops recommendations for deciding such a reform with more support from the public.

Paper 1

Cap or tax? Exploring the potential for a carbon tax or emissions trading in China

Full reference:

Bachus Kris and Cao Jing (2013), Cap or tax? Exploring the Potential for a Carbon Tax or Emissions Trading in China, in: Bruyninckx Hans, Qi Ye, Nguyen Quan Thuan and Belis David, *EU-Asia Climate Relations: Evidence from China and Vietnam as Key Emerging Economies*, Edward Elgar, Cheltenham.



Cap or tax? Exploring the potential for a carbon tax or emissions trading in China

Kris Bachus and Cao Jing

1 | Introduction

China is often blamed for slowing down or even obstructing progress in global climate negotiations, as was shown in the Conference of the Parties (COP) 15 in Copenhagen in December 2009 (Lütken 2010). Most developing and emerging economies find it hard to accept an absolute target for their greenhouse gas (GHG) emissions, viewing it as a potential restriction of their economic development (Cooper 2008). However this observation does not imply that China is not taking any action with regard to climate change mitigation. On the contrary, China has initiated many ambitious policies, such as technology mandates and small-plant shut-down policies in the power sector; vehicle emissions standards; a 1000-firm energy saving programme in the 11th Five-Year Plan and now a 10 000-firm energy saving programme for the 12th Five-Year Plan; feed-in-tariffs and renewable quotas to support renewable energy technologies. Most of the recent policies are command-and-control policies. However, domestically, the instrument choice debate to curb GHG emissions is very lively. As in other countries or regions, the debate largely comes down to the choice between two market-based policy instruments: a carbon tax or an emissions trading scheme.

In this chapter we first analyse the recent and ongoing cap or tax debate in China. We set out theoretical discussions on the instrument choice question. Then, we describe China's current domestic climate policies and measures adopted by China's government for GHG emissions reductions. We assess the arguments for both instrument groups based on China's particular situation and provide a number of design recommendations, before drawing the main conclusions for the Chinese case.

2 | Cap or tax

Although environmental policy science traditionally proposes command-and-control, market-based instruments and voluntary approaches as the three main instrument groups (Arimura et al. 2008), the core of climate mitigation policy can be narrowed down to a choice between two market- based instruments: a carbon tax and a cap-and-trade system (Hepburn 2006). Both instruments put a price on carbon. A tax does this by fixing the price, leaving the resulting emitted quantity undetermined. Emissions trading does exactly the opposite: the quantity is fixed by the policymaker and the price is left to be determined by the market. Apart from these differences, the two instruments have a number of similarities. They both (1) internalize

environmental externalities; (2) can raise government revenues[1] which can be recycled into the economy by reducing other distortionary taxes (Parry 2001); (3) face the risk of 'dilution' because of exemptions and preferential treatment for certain sectors, obtained by lobbying (Edenhofer et al. 2010); (4) require thorough examination of the costs and benefits to determine the appropriate tax rate or the number of allowances (Hepburn 2006); and (5) require specific regulation for implementation, compliance, penalties for non- compliance and a monitoring and enforcement scheme.

The question arises as to which instrument is 'the best' for substantially reducing GHG emissions, taking into account all the relevant decision-making criteria, such as effectiveness, efficiency, competitiveness impact, distributional impact and equity and political feasibility. In theory, in a deterministic world with no uncertainty, price and quantity instruments can both achieve a certain target level of emissions in an equally efficient way[2] (Edenhofer et al. 2010; Newell and Pizer 2003; Hepburn 2006). However, in reality, uncertainty is omnipresent, calling for a more comprehensive approach. Weitzman (1974) showed that, if uncertainty is introduced, one of the instruments may become preferable to the other depending on the relative slope of the marginal benefit and marginal cost curves. He showed that a tax is more efficient than a cap-and-trade system if the marginal benefit curve of the environmental good in question is flatter than the marginal cost curve.[3] Emissions trading is more efficient if the marginal cost curve is flatter than the marginal benefit curve. Applied to climate change, when the benefits of mitigation are not expected to increase quickly, but the costs of further mitigation (after the low-hanging fruit has been picked) are expected to rise rapidly, a price instrument would be the most suitable instrument (Hepburn 2006). Newell and Pizer (2003) and Hepburn (2006) agree that, given the characteristics of the climate change problem, a tax is preferable to a cap-and-trade scheme. Yet, many authors continue to conclude that the theory does not provide a decisive answer to this question (Fan et al. 2011). A lot depends on the perspective or the particular criteria that one uses for this evaluation. In the rest of this section, we will look at this choice issue from other perspectives.

The first perspective, and one which is less frequently debated than the effectiveness and efficiency criteria, is the institutional and design side of the policy instrument. In order for a tax to be efficient, the tax base must be related to the emission itself or at least to the economic factor causing the emission (Edenhofer et al. 2010). Taxes on final consumption are less efficient than input taxes, since the necessary reallocation towards more carbon-friendly alternatives cannot be fully achieved in the case of output taxation. The best tax base is always the emission itself (Oates 1995). As well as the question of the tax base itself, the level of the tax is also crucial. This is clearly a downside of a price instrument: the risk of not achieving the mitigation target by choosing a tax rate that is too low or too restrictive entails suboptimal efficiency (Hepburn 2006). The obvious advantage of permit trading is the fact that achieving the mitigation target (effectiveness) is guaranteed (Edenhofer et al. 2010). However Weitzman (1974) warns that determining the number of tradable allowances and the timing for the issuing of the licenses is as challenging as determining the level of any tax. Conversely, the uncertainty with regard to the timing of the issuing of the licenses can be passed on to the private sector, which is supposedly able to deal with it more efficiently (Edenhofer et al. 2010).

According to Avi-Yonah and Uhlmann (2009), taking all arguments into account, a tax is easier to implement and enforce. A trading scheme requires baselines for emissions reduction targets, a mechanism for distributing allowances, use of offsets, effective administration, a mature legal system, effective monitoring and measuring, and a well-functioning sophisticated market (Fan et al. 2011). Consequently, such a scheme requires experience and cannot be set up rapidly,

whereas a price instrument can become effective in a very short timeframe (Avi-Yonah and Uhlmann 2009). Implementation costs for emissions trading may also be higher than for a carbon tax (Hepburn 2006).

The second perspective to take into account in discussions on instrument choice is the important issue of political feasibility. Although economists primarily focus on efficiency when analysing instrument choice, political feasibility may be a more important factor in day-to-day politics (Hepburn 2006). Cap-and-trade systems are said to be more feasible than taxes (Edenhofer et al. 2010; Stavins 1998; Avi-Yonah and Uhlmann 2009). In fact, Hepburn (2006) states that obstructive industry lobbying can be predicted to increase according to the following order: (1) subsidies; (2) grandfathered licences; (3) auctioned licences; and (4) taxes. Emissions trading schemes are especially easier to implement in times of high energy prices and during economic crises (Avi-Yonah and Uhlmann 2009; Edenhofer et al. 2010).[4] These conclusions are confirmed by the observation that in most policy processes in which the choice between a tax and a cap was explicitly on the table, the cap was ultimately introduced (Stavins 1998).[5] The policy and political process behind the European Union Emissions Trading Scheme (EU ETS) is, in that sense, particularly telling.[6]

A (carbon or other) tax is problematic with regard to public and political acceptability. Since taxes have been used on such a large scale in virtually every country and predominantly for the purpose of raising revenue, they are unpopular with citizens, consumers and businesses alike. Consequently, emissions trading may be more politically feasible than a tax simply because it is not labelled a tax (Avi-Yonah and Uhlmann 2009). According to Nordhaus (2007), a tax is 'almost a four-letter word'. Moreover, besides their general aversion to taxes, people tend to dislike environmental taxes even more than other taxes (Green Fiscal Commission 2009). In this respect, politicians' tendency to grant an (inefficient) free allocation within the framework of tradable permits, which is regarded as a weakness of the instrument, could also simultaneously be seen as its strength. The (inefficient) option of a free permit allocation lightens the burden on the powerful producer groups and offers an attractive compromise to politicians between the advocates of firm climate action and its opponents (Goulder and Parry 2008). Hence, in some cases there may be a trade- off between effectiveness or efficiency and political feasibility criteria for instrument choice. This is illustrated by some experts' fear that, if the market price of the licences becomes too high, politicians may be pressured into relaxing the cap (Avi-Yonah and Uhlmann 2009) which would increase political feasibility, but jeopardize environmental effectiveness. Nordhaus (2007) also points to the difficulty in choosing the emissions baseline to use when setting the absolute cap, whereas a carbon tax is always an extra disincentive for energy use relative to the benchmark of a zero-carbon tax level.

A third perspective that is relevant for instrument choice is that of public finances. In times of harsh fiscal consolidation, such as in Europe in 2012, support for revenue-raising instruments may be higher, whereas instruments with a cost, such as subsidies, become less feasible. In theory, a tax and a tradable permit system with full auctioning could raise government revenue in a similar way. However according to Hepburn (2006), in practice a price instrument such as a tax may raise more government revenue than emissions trading, even with fully auctioned permits, because auctions will not always raise the optimal amount of revenue.[7] In a comprehensive revenue-neutral 'environmental tax reform' (ETR), revenues from environmental taxation are reinvested in the economy by lump-sum payment, reduction of other distortionary taxes or other recycling mechanisms (Ekins 2011). One drawback of the tax from this perspective is the unpredictability and unstable nature of the potential revenue. This uncertainty may hinder an ETR process: trade unions for instance tend to be worried that if the

tax base of the environmental good erodes, government will revoke the reduction in the social security contributions.

A fourth relevant perspective is the robustness of both instruments with regard to market failures. According to Edenhofer et al. (2010), the price instrument clearly has the advantage in relation to this criterion. The quantity instrument may entail higher welfare losses in capital, permit or resources markets. Apart from severe failure or collapse, a smaller troublesome feature can be strong volatility in the permit price, which has been one of the undesirable characteristics of the EU ETS (Ekins 2009).[8] One way of dealing with this complexity is to turn the trading scheme into a hybrid instrument, combining emissions trading with features of a tax. In practical terms, a floor and a ceiling may be added to the scheme, protecting against both undesirably high and low permit prices. In practice, this would mean that the government (represented by a 'carbon bank') would commit to buying or selling part of its own stock of licences when the price goes beyond the floor or ceiling level (Hepburn 2006; Ekins 2009).

The final perspective is the impact on innovation and the diffusion of pollution abatement technologies. Montero (2002a) and Coria (2009) examined the incentives for adoption under the tax and trading regimes, assuming firms engage in imperfect competition in the output market. Both authors break down the policy impacts into two effects: direct effects and indirect strategic effects. The former suggests that, if firms compete in quantities sold, research and development (R&D) will allow investors to reduce the marginal cost of abatement, with the result that the direct effects are positive and investors' abatement savings do not affect the other firms' choice of output. Assuming imperfect competition, there is one more effect imposed upon this direct effect: the strategic effects would be negative for innovation and diffusion since investors' decisions affect the *ex post* behaviour and profits of their rivals. Montero (2002a) argues that tradable permits offer fewer incentives than the tax if the regulator is myopic and does not adjust the tax rate or cap in response to the availability of new technologies. However Coria (2009) adopts a more dynamic approach: by assuming that the regulator commits to the *ex post* optimal environmental policy, she shows that the ranking of the tax and tradable permits depends on the elasticity of output demand. If output demand is more elastic, direct effects will be larger under the permits than under the tax and the regulator speeds up the entire sequence of adoption by using auctioned permits. In summary, choosing the optimal instrument for climate mitigation policy is a complex matter. On the one hand, a small majority of scholars find that, given the characteristics of the climate problem, the features of the different markets involved and the available knowledge with regard to multiple evaluation criteria, a tax may be the most efficient choice for climate change mitigation policies. On the other hand, the choice that policymakers have in reality is often restricted by contextual factors, such as political support and reliability of emissions data. We will discuss this question in more detail in the case of China.

3 | China's domestic climate policy

3.1 Climate Policies in China

China has implemented various policy options in the 11th Five-Year Plan period (2006–2010), in order to reach its energy intensity target of 20 per cent by the end of 2010,[9] compared to the benchmark level of 2005. Major policies include:

- Energy intensity target and energy saving responsibility policy: using a top-down energy intensity target break-down method, provincial and local governments and major firms are aligned with energy intensity targets at each level. Achieving the assigned target plays an important role in terms of government officer promotion and enterprise development.
- Technology mandates and shutting down small-scale power plants: various building codes and new emissions standards were adopted in China. In the power sector, 76.8 GW of capacity from small-scale power plants under 100 MW has been phased out.
- Phasing out inefficient production in cement, iron and steel and other energy intensive sectors: shutting down small and pollution-intensive firms in the paper, chemicals and textile sectors, and so on. Meanwhile, the Chinese government also grants subsidies to compensate for the loss.
- Top 1000 energy consuming enterprise programme: the Chinese government has set specific energy saving targets for the selected 1000 highest energy consuming enterprises in the iron and steel, chemicals, electricity power generation, petroleum/petrochemical, construction materials, non-ferrous metals, coal mining, paper and textile industries. Progress is being monitored closely and enforcement is strong. According to a central government report, the top 1000 enterprises have saved roughly 150 Mtce between 2005 and 2010, achieving 50 per cent more savings than the required target (Government of China 2011).[10]
- Preferential tax rates for renewable energy and energy conservation technology ventures: the new Enterprise Income Tax Law (EIT) came into force on 1 January 2008. This law introduces preferential treatment for industries and projects in the areas of environmental protection, energy conservation, water conservation, technology transfer and nuclear development by reducing enterprise income tax and providing tax holidays. In addition to qualifying for the EIT benefits, energy service companies are also exempt from business tax and value added tax (Montero 2002b).
- Tariff adjustment: the Chinese government has reduced import tariffs on resource-efficient and advanced technology commodities but increased export tariffs and removed export rebate subsidies on energy-intensive, pollution- and resource-intensive commodities during the 11th Five-Year Period.
- Fuel tax reform: the Chinese government launched a fuel tax reform in 2009, which set the petrol tax at 1.0 yuan/l and the diesel tax at 0.8 yuan/l.
- Resource tax reform: the Chinese resource tax was reformed in October 2011. Under the new regime, crude oil and natural gas taxes have been shifted from a unit tax to an ad valorem tax, that is, the tax will be based on sales rather than on production. In addition, coking coal and rare earths were also subject to higher tax rates (China briefing 2011).
- Green credit policy: launched in July 2007, the Green Credit Policy has become an important climate financing tool in China, with three government agencies sharing implementation responsibilities – the Ministry of Environmental Protection (MEP), the People's Bank of China (PBoC) and the China Banking Regulatory Commission (CBRC). This policy implements a shift in credits from polluting and energy-intensive enterprises and projects towards conservation and emissions-abating projects. Under this policy, the share of energy saving environmental project loans has grown from 1.87 per cent of total loans granted by Chinese banks in 2005 to 8.93 per cent in 2009 (China banking Association 2012).
- Carbon sinks: the State Forestry Administration launched three major programmes to increase carbon sinks in China: (1) major programmes such as the natural forest protection

programme, the sloping land conversion programme and the Beijing–Tianjin sand control programme; (2) Clean Development Mechanism (CDM) carbon sink projects; and (3) the voluntary afforestation programme under the China Green Carbon Foundation.

In summary, the major policy interventions adopted by the Chinese government during the 11th Five-Year Plan are predominantly command-and-control policies. Although some innovations regarding market-based instruments have been adopted on a supplementary basis, most of these are adjustments to trade tariffs, banking policies and preferential tax treatments.

In the 12th Five-Year Plan (2011–2015), the Chinese government announced a 16 per cent energy intensity reduction target,[11] a 17 per cent carbon intensity reduction target (NDRC 2012), an (absolute) energy consumption target of 4.1 billion tce and a coal consumption target of 3.9 billion tonnes.[12] However these targets seem difficult to achieve, especially the coal target, since coal consumption has already grown to 3.8 billion tonnes in 2011 (Bloomberg 2012), meaning that it can only increase by 0.1 billion tonnes for the next five years. Furthermore, even given the condition to limit total energy use to under 4.1 billion tce, China's fossil fuel-related carbon emissions would reach 8.5 billion tonnes in 2015, which would surpass United States (US) emissions by about 50 per cent (Montero 2002a). With the further stringent targets for the 12th Five-Year Plan, there is a growing understanding that the existing command-and-control policies will be largely insufficient. As a consequence, the importance of economic instruments in the climate policy debate is growing.

3.2 Environmental Taxation in China

The debate on environmentally related taxes in China is not a new one. In 1982, the pollution levy system was put in place to curb industrial pollution relating to water, air, noise and solid waste (Wang and Wheeler 2000). This comprehensive reform also introduced the new resource tax, the vehicle tax and the land use tax. One year later, the fuel tax, levied on petrol and diesel, was added. In 1985, the urban construction and maintenance tax followed and in 1988, a tax on land use was imposed. The 1994 tax reform was aimed at making the tax system more consistent with the needs of the market economy (Xu 2011). It reformed the resource tax and launched the consumption tax, which was levied on 14 types of consumer goods, including transport fuel, disposable chopsticks, tobacco, alcohol and cars. The consumption tax included a new vehicle tax, which was divided into the one- off vehicle acquisition tax at purchase and the annual vehicle and vessel tax. In 2003, the industrial levy was reformed and replaced by a pollution tax.[13] Although the reform involved a significant increase in the tax rates, they were still too low to have the desired impact (Xu 2011). Further reforms were implemented after this, including the fuel tax reform in 2009, which had been under debate for 15 years before finally being adopted (Bachus and Cao 2011).

In 2010, China's environmental tax revenues accounted for 6.7 per cent of total tax revenues, which is slightly higher than the average for the EU27 (6.3 per cent) (European Commission and Eurostat 2011; National Bureau of Statistics of China 2012). However, expressed as a percentage of gross domestic product (GDP), these revenues are 1.2 per cent, significantly lower than the EU's (2.4 per cent). This difference can be explained by the much lower general tax level in China (Bachus and Cao 2011). Another measure is the tax rate excluding value-added tax (VAT) on petrol, which was €0.11 per litre in China, compared to €0.08 in the US, €0.66 in Germany, €0.62 in the UK and €0.61 in France (European Commission 2012; Ministry of Finance 2012).

Chinese environmental tax policies have been especially criticized for their low tax rates. As most of the revenues are used for pollution abatement, the tax rates are calculated to cover only the abatement costs. Experience has shown that this level is too low to be an incentive for companies to invest in emissions reductions, as it is cheaper to pay the tax than to abate (Bachus and Cao 2011). Secondly, due to China's complex institutional structure, problems of conflicting interests between local and central governments frequently occur, leading to collection rates that are much lower than could be expected given the tax rates. Local governments are often zealous for local economic growth, which makes it hard to adopt and implement any environmental tax that may conflict with these targets (Xu 2011). The 2009 fuel tax reform may seem like a significant step forward, but the increase was the first one in 26 years. Other taxes, such as the independent environmental tax and the carbon tax, remain to be realized (Wang et al. 2011).

3.3 Emissions Trading Experience in China

Until today, China has not yet had a comprehensive system of emissions trading (Chang and Wang 2010). However the severe problems in China with sulphur dioxide (SO_2) from coal have raised strong awareness, leading to a search for effective policy instruments to deal with the air pollution problem. SO_2 emissions trading has been the focus of serious attention for the last 20 years. As early as 1994, emissions trading pilot projects were launched in six cities (Yang and Schreifels 2003). In the late 1990s, China implemented a number of pilots with the help of the US and several international institutions (Chang and Wang 2010). This led to an upscaling in the early 2000s, with experiments in four provinces, three cities and one power production company. Different types of trading were tested during these experiments. The pilots revealed a number of barriers and challenges for effective implementation of emissions trading on the national level (Chang and Wang 2010). The first was effective emission monitoring capacity, which was lacking. The second was a solid legal system, which was insufficient. Thirdly, many institutions from local and central government need to be engaged, making the ETS a very complex system. Finally, compatibility with other regulations and policies needs to be addressed carefully. Although much has been learnt from the pilots and some local trading schemes are still operational today, they have not entailed a national cap-and-trade system and most authors consider them as having failed (Han et al. 2012).

Carbon trading entered China in 2004, when it embarked upon the Clean Development Mechanism (CDM). It quickly became the world's most dominant CDM carbon credit supplier, accounting for 58 per cent of global certified CDM emissions reductions at the end of 2011 (UNEP Risø Centre 2012). Next to the CDM, carbon trading is also present in China through the 'carbon trade exchanges', such as the China Beijing Environment Exchange (CBEEX) and the Shanghai Environment and Energy Exchange (SEEEX). Although today these initiatives only trade CDM and voluntary Emissions Reductions, Han et al. (2012) see them as a way of providing a basic infrastructure for future carbon trading on a larger scale.

However the most important initiative recently taken with regard to carbon trading in China is the decision, in 2011, by the National Development and Reform Commission (NDRC) to launch pilot carbon trade projects in two provinces and five cities.[14] Implementation is set to start in 2013 and it should pave the way for a nationwide system by 2016.[15] Some governments in the pilot areas will implement a pure cap-and-trade scheme, meaning they will launch an absolute cap. Other areas' governments will opt for efficiency-based or project trading schemes due to their opposition to an absolute cap (Wu 2011). Chinese trading is quite different from the EU

ETS or the US sulphur trading regime. In fact, since the central government allows each member province or city to design its own trading regime, they all have their own plans and systems. For instance, in the case of Beijing, all firms with average annual carbon emissions of 10 000 tonnes and up are obliged to join the trading programme (roughly 600 firms) (China Daily 2012). The remaining firms can join on a voluntary basis. The cap is not an absolute carbon emissions cap, but a carbon intensity target of 17 per cent, which is the 12th Five-Year Plan target for Beijing. The quotas are distributed through grandfathering, depending on firms' historical emissions, technology and the city's industrial structure. Since trading prices may be quite volatile, the government may set a price floor if the trading price is too low or may provide more quotas via auctioning if the price is too high. The absence of an absolute cap, and the uncertainty in the economy, give rise to doubts as to the functioning of the pilots, but they leave room for trial and error adjustments. Unlike Beijing, which covers all the energy-intensive sectors, Guangdong plans to start with electricity, building materials and the chemical sector and expects to implement trading in 2014 (Lunsford and Loh 2012). As Guangdong's 12th Five-Year Target is 19.5 per cent, the provincial government further translates its target into a cap on the level of the firm, so that firms can trade to achieve their own target.

For all pilot cases, it can be said that, since trading is limited to the city or provincial jurisdiction, the trading market is potentially very thin, meaning that transaction costs may be quite high. In the case of Beijing, only 600 firms are included and in the case of Guangdong, only three sectors are allowed for trading purposes, with the result that the trading volume might be too low to ensure efficient trading.

4 | Policy Choice for China

4.1 A Chinese Cap or a Carbon Tax?

In the previous sections we discussed the theoretical debate over the cap-and-trade and carbon tax and we reviewed the current experiences of China with regard to climate policy, environmental taxation and emissions trading. In this section, we apply these discussions to the Chinese perspective.

Firstly, from the perspective of administrative efficiency, a carbon tax clearly has the edge on allowance trading. According to Ye and Wang (2009), a carbon tax would be relatively easy to implement as the tax can be collected indirectly based on the carbon content of the fuel. In this way, the tax could be set up by tax authorities, even without the technical support of the environmental department. Moreover, Ye and Wang (2009) see no major departmental obstacles. On the other hand, emissions trading in China requires a prodigious administrative framework and a transparent and accurate carbon accounting system. Notwithstanding the initial preparations for emissions trading described in the previous section, a sound emissions trading market in China is still in its infancy (Han et al. 2012). The same can be said for the pilot projects that have been launched recently. One field that needs solidification is the legal framework, particularly in the area of enforcement (Cheng and Zhang 2011). According to Han et al. (2012), there is a lack of reliable emissions data,[16] and setting emissions caps[17] and allocating permits would be particularly challenging. Thus, despite the efforts already made, the capacity to implement a large-scale carbon trading scheme is not yet present. It will take time for both private firms and local governments to learn from the pilot trading market and to bring

down the transaction costs of any new system and shift the trading market from a thin market to a thick market to assure trading efficiencies (Cao 2010a).

Secondly, as in most countries, political factors are likely to be a crucial factor in the choice between taxing and trading. People naturally have an aversion to any tax, as China's tax burden has risen sharply in the past 15 years.[18] Moreover, the excessive zeal for economic growth,[19] especially at the local level, is expected to raise opposition to the introduction of a carbon tax (Li et al. 2011). China lacks a sound, efficient and transparent budgeting and accounting system for public money, which has led to a general distrust and suspicion by citizens and business that government would waste any new tax revenues (Xu 2011). The experience of the 2008 fuel tax reform, which had less impact than a carbon tax would, has taught that such tax reforms in China face a very long and difficult political process before implementation (Wang 2009). Surprisingly, a survey cited by the Asian Development bank (2007) reported that 99 per cent of the public support 'collection of environmental taxes'. However Ye and Wang (2009) believe that taxpayers will certainly resist the carbon tax. Liang et al. (2007) estimated the impact of several carbon tax scenarios for China. They estimate that only a scenario involving total exemption for energy-intensive sectors can be expected to be politically feasible.

As a developing economy, China is resistant to an absolute national emissions cap, as it may curb its economic growth (Cooper 2008). According to Wu (2011), China can benefit economically from domestic emissions trading, but a lack of political will for pricing carbon has hampered progress; moreover, an emissions ceiling reducing over time is just as politically unacceptable. However current practices show that the idea of an ETS has gained momentum in recent years and now seems the preferred option for the Chinese government, as a new carbon tax may lead to more resistance (Wu 2011). Similar to the EU ETS, it is likely that China will start from grandfathered allocation, to gradually shift to a combined grandfathered–auctioned type of allocation. It will be interesting to see how the policy reforms will change power divisions within the central government. The Ministry of Finance (MoF) would prefer a tax if the revenue is added to the general budget, but the MoF would have a neutral attitude if the carbon tax revenue is fully recycled by lowering other taxes. However the NDRC would prefer a trading regime, since it is responsible for determining and allocating the caps. Local governments would support a trading regime as well, as the (local) pilot trading programme currently implemented in China gives them the power to design the trading regime. Consequently, local governments can design the policies so that they hinder local economic growth as little as possible. Of course, such design power will be lost in the event of a nationwide system.

The third criterion in the instrument choice discussion is effectiveness. Several studies have been conducted on the effectiveness of different carbon tax scenarios. All studies agree that there is no doubt that a carbon tax would be an effective instrument for Chinese climate mitigation policies (Cao 2010b; Cao 2010a; Wang et al. 2009; Liang et al. 2007). An auction-based cap-and-trade scheme is likely to achieve similar performance in emissions abatement since the permit price will send similar price signals. A grandfathered trading regime would depend on the cap-setting and the features of the trading market but is likely to yield suboptimal results.

A fourth important element is the impact on the divide between rich and poor in China. The Chinese government aims to reduce this gap and is afraid that rising energy prices may exacerbate inflation and be unfavourable for the poor (Wu 2011). The distributional impact of a carbon tax in China has been calculated by Cao (2010b). She concludes that a carbon tax would indeed be regressive, but also that this effect can be fully neutralized by recycling the tax

revenues into the economy. In her simulations, the lump-sum recycling scheme reduces the regressive nature of the tax more than the option in which other distortionary taxes are reduced. The net effect of the tax reform can even be made positive for low-income households, which turns it into a progressive measure. This conclusion is supported by Brenner et al. (2006), who raise the idea of combining a carbon tax with a 'sky trust', a system of carbon charges in which the revenues are recycled to the public on a lump-sum basis. According to this study, such a tax reform will have a progressive distributional impact.

A fifth element is the competitiveness impact. Ye and Wang (2009) and Cao (2010a) indicate that a carbon tax will affect energy prices, which may reduce industrial international competitiveness. Cao (2010a) points out that, if neither instrument is implemented in China, China's exporting industry might be confronted with border taxes in the future,[20] which might also hurt China's competitiveness, but without the possibility of recycling the revenues. Wang et al. (2011) confirm that a high carbon tax (100 yuan per tonne of carbon) would necessitate compensation for industry. However a low rate of 10 yuan could be implemented immediately as a first step with hardly any competitiveness impact for any sector expected. Similarly, for the domestic trading scheme, cross-region competitiveness may arise as well, especially between trading regions and non-trading regions. However, with the pilot period, this may be a small issue and will be reduced in the long term when the trading regime expands to the whole country. A domestic carbon tax with the same tax rate across the country can avoid such risks, unless certain sectors are exempt or receive preferential tax rates.

A sixth point of attention is compatibility with other existing policies. A carbon tax may interfere with the resource tax and the consumption tax (fuel tax). In order to avoid double taxation, a serious coordination effort will be required to align the new instrument and make it complementary to the existing measures. The same requirement can be formulated for a tradable permit scheme, which will also need coordination with existing environmental policy measures, such as the existing (unsuccessful) sulphur trading programmes.[21]

A seventh element is the aforementioned trade-off between effectiveness and political feasibility. If the Chinese government decides to implement a comprehensive emissions trading scheme, free allocation of permits should be strongly advised against in order to avoid an erosion of effectiveness. However given China's experiences with difficult and obstructed policy processes such as the energy tax (Wang 2009), the fuel tax reform (Bachus and Cao 2011) and the SO_2-emissions trading policy process (Yang and Schreifels 2003), the government's emphasis on a step-by-step approach and the use of pilot projects (Wang et al. 2011), it is not very likely that in a first phase such an ETS will have a large share of auctioned permits. In addition, it is likely that China's ETS, if adopted, will allow for additional emissions growth, just less than in the business-as-usual scenario (Wu 2011). This decision to allocate free licences will be detrimental for carbon emissions reductions, but may – as a way of compromise – at least generate enough political support for this first step towards the pricing of carbon emissions in China.

The eighth and final difference between cap-and-trading and taxes in China lies in their impact on technology innovation and diffusion. However due to the lack of empirical studies of the impact of the two instruments on R&D and technology innovation and diffusion in China, it is hard to tell which instrument will give more incentives.

4.2 Recommendations for the Optimal Design of a Cap or a Carbon Tax in China

Regardless of whether emissions trading or a carbon tax (or both) is chosen, the design of the system will be crucial for its chances of success. In this subsection, we put forward a number of recommendations for designing a carbon tax or a tradable permit system.

In the case of a carbon tax it is important to gradually increase the tax rate over time. This avoids the negative shock effects of a too drastic new tax and the petering out of abatement efforts after a certain time. Since actively raising tax rates on a regular basis is likely to bring about problems with public acceptance, the tax levels should be announced before the start of the programme. Additionally, an automatic link with inflation is advised. The tax reform should be combined with a comprehensive communication campaign explaining the reasons for the reform and transparently reporting on the (financial) impact on all groups of citizens and companies in China. The tax base can be the carbon content of fuels, so exact emission measurement is not required.

The most important recommendation for tradable emissions rights is to maximize the amount of paid allocation of allowances. Auctioned allowances increase effectiveness and open the door for revenue recycling, which offers a solution to any undesired incidental impacts of the programme, such as hurting low-income groups and competitiveness issues. Fan et al. (2011) recommend small, frequent auctions to limit the market power of large bidders. Next, a lot of attention should be given to the design of the trading system, much more so than for a carbon tax. Although in the pilot programme different cities and provinces have designed different trading regimes, in the actual implementation the central government will need to implement only one trading regime and allow firms to trade across city or province borders. Last but not least, China should get its house in order regarding the reliability of emissions data before considering a nationwide cap-and-trade system.

The last group of recommendations is valid for both instruments. Firstly, whichever instrument is chosen, the price put on carbon should be high enough in order to have a significant effect on investment and consumption decisions. Secondly, the revenues from the carbon tax or the auctioned permits should be recycled as much as possible into the economy, thus avoiding or at least mitigating to a large extent any undesired regressive or negative competitiveness impacts and simultaneously increasing public support for the reform. Thirdly, exemptions or rebates for individual sectors should be barred or at least kept to a minimum as this leads to suboptimal social welfare. Fourthly, instead of focusing too much on the upsides and downsides of any single policy instrument, it is better to abandon this exclusiveness approach and strive for a policy mix. If well-coordinated, it is feasible to combine a tax with an ETS, regulation, subsidy removal, voluntary approaches and other options. Indeed, implementing a carbon tax in China in the short run, and later on complementing it with an ETS that could gradually become the dominant carbon pricing instrument, is probably the most suitable solution (Fan et al. 2011). Alternatively, both instruments can be applied to different sectors; for instance, cap-and-trade could be used for the currently already monitored 10 000 energy-intensive firms, supplemented with the highly-regulated sectors, such as electricity, iron and steel and the cement industry. The other sectors and medium or small-scale firms can be regulated with a carbon tax. Such a ‘hybrid system’ (see above) combines the advantages of both instruments and could be an option worthy of consideration in the case of China.

5 | Conclusions and recommendations

Taking into account all the pros and cons of a tax and an ETS, the conclusion as to the optimal climate change mitigation instrument for China is not entirely straightforward. However an emissions trading scheme will only be able to achieve its theoretical potential if the critical conditions of a sound administration, reliable emissions data and a well- functioning market are achieved. This is regarded to be highly unlikely in the short term. Therefore, a carbon tax may be the most feasible option, at least from an administration and implementation point of view (Cao 2010a; Fan et al. 2011). In the longer term, a cap-and-trade system can replace the carbon tax or supplement it. A hybrid system combines the advantages of both instruments, but the increased complexity may jeopardize implementation. Regardless of which instrument is more effective, efficient or administratively feasible, in practice political considerations will probably end up being the decisive factor. Local and central government institutions' power and other policy priorities, such as safeguarding economic growth and avoiding negative distributional impacts, are likely to play a larger role in practice than effectiveness or efficiency. In our view, choosing which one of the two instruments is most appropriate is not the main challenge for China in the near future. The principal challenge may well be simply reaching a decision to implement at least one ambitious, sound and credible climate policy instrument. China's domestic climate mitigation policy may well be the decisive factor determining whether global climate efforts will reach a turning point or continue to decline in the years to come.

6 | Notes

1. For tradable permits this is only the case if the allowances are not provided for free but allocated against payment (for example auctioned).
2. Again, this theoretical equivalence only stands in the case of paid allocation of permits (by auction or other). If the allowances are (partially) granted for free ('grandfathered'), emissions trading is less efficient than a tax in any case (Parry 2003).
3. Assuming both the marginal cost and the marginal benefit curves are linear functions, following Adar and Griffin (1976).
4. However it is not hard to imagine that the same can be said for a carbon tax. For example, Ireland decided to impose a 'pure' carbon tax (without revenue recycling) as part of its crucial fiscal consolidation package in 2009–2010 (Bergin et al. 2010).
5. For example the EU Emissions Trading Scheme, the Kyoto mechanism and the New Zealand ETS. One counterexample is the Australian carbon tax, which was introduced after a bumpy, multiple-year political process (Clarke and Waschik 2012).
6. Before the ETS was adopted, a Europe-wide carbon tax had been put on the agenda by the European Commission as early as 1991. See, among others, Wettestad (2005), Ellerman et al. (2010) and Skjærseth and Wettestad (2008). The latter states that 'the tax proposal led to some of the most ferocious lobby activity ever seen in Brussels' (2008: 4). As a result of this lobbying and the unanimity rule, the idea of a common carbon tax was abandoned in 1994.
7. For reasons of susceptibility to manipulation and barriers to new entrants (Hepburn 2006). The optimal design for an efficient ETS system is a complex matter (Woerdman and Weishaar 2010), on which an extensive body of literature has been published which goes beyond the scope of this chapter.
8. The price of the (phase I) European allowances even fell to zero for about one year in 2007, caused by the transition from the first to the second trading period, among other reasons (Ekins 2009).

9. According to Qi (2011), the actual energy intensity reduction achieved at the end of 2010 was 19.06 per cent.
10. The savings mentioned are not absolute reductions, but reductions from a calculated business- as-usual baseline.
11. By the end of 2015 compared to end of 2010 levels.
12. It is the first time that China has proposed an absolute energy and coal target.
13. Therefore, this reform is also called the 'fee-to-tax reform'.
14. The provinces of Guangdong and Hubei and the cities of Beijing, Shanghai, Tianjin, Chongqing and Shenzhen.
15. According to Wu (2011), this is a very ambitious goal, given the number of issues that can be expected to have limited support: (a) opposition from within government; (b) China's energy consumption and prices; (c) expected inflation and potential regressive impact; (d) uncertainty with regard to intensity targets; and (e) lack of experience by industry in measuring and managing emissions.
16. This observation is confirmed by the recently published article by Guan et al. (2012) in Nature Climate Change, in which the authors argue that China's official national carbon emissions and the combined total reported by all provinces differ by 1.4 gigatonnes, which is approximately the amount of the fourth-largest emitter in the world, Japan.
17. Including converting the existing carbon intensity targets into an absolute cap.
18. Sun (2012) calculated that the Chinese macro tax burden (that is, including social insurance revenue) has risen from 11.6 per cent of GDP in 1995 to 22.7 per cent in 2010.
19. Especially at the local level.
20. The recent inclusion of aviation in the EU ETS and the subsequent levy for international air carriers can be regarded as the first border tax adjustment.
21. Sulphur trading is still operating on a local level in seven areas in China (Petherick 2012). Chongqing seems to have the best market; the other areas suffer from low trading volumes.

7 | References

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Paper 2

How to tell green from grey? Towards a methodological framework for evaluating the greening of national tax systems

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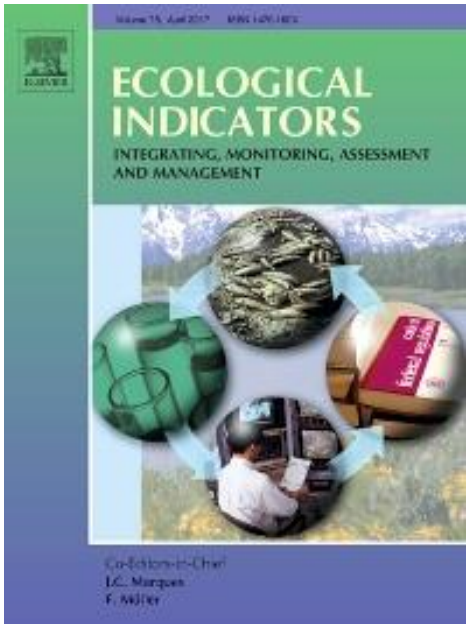

Ecological Indicators

How to tell green from grey? Towards a methodological framework for evaluating the greening of national tax systems

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abstract

In this paper, we evaluate four types of indicators that can be used for measuring the greening of a tax system: revenue-based indicators, single tax rates, aggregate tax-rate based indicators and the implicit tax rate on energy. We develop an evaluation framework, introducing two principal evaluation criteria: content validity and comprehensiveness, and four statistical criteria: data availability, comparison over time, international comparability and ease of aggregation. Additional analysis regarding the issue of weighting is carried out for the aggregate tax-rate based indicator. The theoretical and methodological evaluation is supplemented and validated empirically using recent data on the Belgian and Flemish tax system. Finally, conclusions are drawn with regard to the strengths and the weaknesses of the four types of indicators, and recommendations are made for further research.

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1 | Introduction[26]

Pigou (1920, 1960) argued that taxes should be levied to internalize negative externalities, such as pollution. After Pigou, a whole body of literature emerged, agreeing that taxation is an effective and efficient instrument to reach environmental objectives, and that environmental taxation currently is underused in the combat against environmental problems. Therefore, both academics (e.g. Avi-Yonah and Uhlmann, 2009; Baumol, 1972; Ekins, 2011) and international agencies such as the European Environment Agency, the European Commission and the OECD also consistently urge lagging member states to step up their use of environmental taxation.[27]

A first advantage of environmental taxation is obviously an improvement of the state of the environment (OECD, 2006). Secondly, the additional government revenue creates room for reducing other, more distortionary, taxes, such as labour taxes or corporate income taxes (Speck and Datta, 2009). Recycling tax revenues that way may reduce negative competitiveness and distributional impacts (Ekins and Speck, 1999; Metcalf, 1998; Parry, 1995), and would make the reform more politically acceptable (Dresner et al., 2006). Such a 'green tax reform' aims at realising a so-called 'double dividend', combining an improvement of the state of the environment and a reduction of unemployment.[28] Thirdly, the revenues from environmental taxation offer chances for fiscal consolidation (e.g. OECD, 2010b). Speck and Gee (2011) call environmental tax reforms "a valuable measure for dealing both with short term budgetary imbalances and spurring the transition towards a green economy". Ireland gave environmentally related taxes a central place in the budgetary reforms in 2010, which may lift the country to the level of the frontrunners in the EU in terms of greening of the tax system (Andersen, 2010). Finally, like any other tax, environmentally related taxes offer the politically attractive option of earmarking, in which case the revenues are used for a specific (environmental or non-environmental) goal: for instance, water pollution charges used for water purification purposes (Marsiliani and Renstrom, 2000). Theoretically, earmarking revenues for other environmental investments and expenditures is not an efficient use (Brett and Keen, 2000; Laskowska and Scrimgeour, 2002). In practice, however, it may increase public and (hence) political support as public opinion tends to prefer earmarking to revenue recycling (Oates, 1995; OECD, 2001).

Based on the above theoretical arguments, the call for increasing the use of environmental taxation – or for 'greening national tax systems' – to combat environmental externalities is

[26] This paper builds on earlier work that was published in a book chapter: Bachus (2012).

[27] For example, in the Roadmap for a Resource Efficient Europe (2011), in the Annual Growth Survey for 2011 and in the European Council Conclusions from March 2011 (European Commission, 2011). For the case of Belgium, a country with a weak tradition in environmental taxation, the OECD has explicitly stated that recommendation as early as in its 1998 Environmental Performance Review on the country (OECD, 1998). It has repeated this plea in its 2007 Environmental Performance Review on Belgium (OECD, 2007). The European Commission, through the European Semester recommendations, has been recommending Belgium to implement a green tax shift for six consecutive years now, from 2011 to 2016.

[28] Some authors support the hypothesis that the (strong) double dividend can be achieved (Pierce, 1991), while other scholars have rejected it (Bovenberg and de Mooij, 1994) or claim it strongly depends on the structure of the economy (Bento and Jacobsen, 2007; Schöb, 2003).

justified. However, it creates the need for a framework to assess countries' progress made towards the goal of greening the tax system in practice. Indicators for the greening of a tax system can fill in that need, especially because they fit in the trend towards more national reporting on indicators for environmental quality.[29]

Up to now, the greening of a tax system is predominantly measured using two indicators: the revenues from environmentally related taxes as a percentage of GDP, and the revenues from environmentally related taxes as a percentage of the total tax revenues. Both revenue-based indicators have merits but also a number of drawbacks. The aim of this paper is to evaluate that prevailing type of indicator along with three alternative types of indicators measuring the greening of a tax system: single tax rates, aggregate tax-rate based indicators and the implicit tax rate on energy. We develop an evaluation framework, introducing two principal evaluation criteria: content validity and comprehensiveness (infra), and four statistical criteria: data availability, comparison over time, international comparability and ease of aggregation. In that evaluation, the aggregate tax-rate based indicator needs additional analysis, since it requires adequate application of index number theory, more specifically to address the issue of weighting. We explore if a Lowe or a Laspeyres index is the best fit for evaluating the greening of a tax system. After testing the theoretical findings on the index numbers, we compare the four types of indicators. Finally, conclusions are drawn with regard to the strengths and weaknesses of the four types of indicators, and recommendations are made for further research.

2 | Conceptual framework

Except for the theory of Pigouvian taxation, there is no clear theoretical framework behind the call for 'more' environmental taxation. Two terms are often used in these discussions: the greening of the tax system and environmental tax reform (ETR).[30] The latter term is usually defined as "a reform of the national tax system where there is a shift of the burden of taxation from conventional taxes, for example on labour, to environmentally damaging activities, such as resource use or pollution" (European Environment Agency, 2005). The term 'greening of a tax system' is used less frequently. We define it as "an increasing emphasis on the environment in the tax system". To operationalize that theoretical concept, we distinguish three ways of greening the tax system: an introduction of new environmentally related taxes (e.g. a newly introduced carbon tax), an increase in the tax rates of existing environmentally related taxes (e.g. increasing fuel tax rates), and an increased use of environmentally relevant clauses in the design of non-environmentally related taxes.[31]

[29] A number of environmental taxation indicators are already part of the European Environmental Accounts (Eurostat, 2010).

[30] Variations on this last term are ecological tax reform, green tax reform and environmental fiscal reform. The term 'fiscal' usually adds subsidies to the research scope.

[31] This means including environmental factors such as energy saving potential (e.g. for real estate taxes) or carbon emissions (e.g. for car taxes) in the calculation. That third way of greening will be further left outside of the scope of this article.

It should be noted that the definition of the term 'environmentally related taxes' as put forward by the OECD, quickly implemented by European Commission and Eurostat (2001)[32] and followed by nearly all authors ever since, holds the choice for a unilateral focus on the tax base, and not on the goals of the policy instrument. As a result, taxes with an environmentally relevant tax base but no environmental goal[33] are included in the definition.

Bruvoll (2009) calls for a strict distinction between environmental taxation, which are only Pigouvian taxes with an environmental goal, and environmentally related taxes, a term which refers to the taxes with an environmentally relevant tax base. She calculated the tax revenues for both groups of taxes for Norway and found that the environmental taxation (in the strict sense) revenues were only one fifth of the revenues using the tax base-definition. Even if we consider that reflection as a useful remark, it is beyond the scope of this paper to further examine that thesis. As a result, the study in this paper concerns the use of environmentally related taxes by countries, which is not per se a good measure of the degree to which a country uses taxation as an instrument to achieve environmental policy goals.

3 | Evaluation framework

Indicators are used "to simplify information that can help to reveal complex phenomena" (EEA, 2013). Indicators can be either theory-driven or data-driven. The latter attaches great importance to data availability[34] when developing and selecting indicators, whereas the former is primarily concerned with the validity of the indicator (Niemeijer and de Groot, 2008). Content validity refers to the degree to which the indicator chosen actually measures the theoretical concept that it claims to measure (Billiet and Waege, 2003). In that approach, data availability is merely a side condition (out of many).

In this paper, we propose a combined approach. On the one hand, we will use content validity as the central evaluation criterion and treat it as a criterion for exclusion. Whether data or theory driven, if there is a gap between the theoretical concept and what the indicator measures, reliable conclusions are not within reach. However, we also support the view of Turnhout et al. (2007), who claim that discussions and studies on indicators often neglect the importance of the political context. Indicators with high content validity but poor practical, statistical and communication potential, are likely to suffer from low utilization. That observation is supported by the fact that the Statistical Guide on Environmental Taxes (European Commission and Eurostat, 2001) puts special emphasis on the policy-relevant criteria international comparability and data availability.

Based on those arguments, we select two evaluation criteria in the 'validity' group, which is the core group, and four indicators in the 'utilization' group, referring to the practical usability for the users of the indicators, which are mainly international and national policy and

[32] This definition was agreed for reasons of comparability and data availability. Remark that the OECD has an even longer history referring to the polluter pays principle, a concept that also makes the link with the internalization issue.

[33] Transport fuel taxes are an example of an environmentally related tax with (in most cases) no explicit environmental objective.

[34] And to statistical utilization, comparability over time or place and communication potential.

statistical institutes. We call the latter group 'statistical criteria'. Table 2 summarizes our evaluation framework.

Table 2. An evaluation framework consisting of two core criteria and four statistical criteria

Core criteria (validity group)	Content validity Comprehensiveness
Statistical criteria (utilization group)	Data availability Suitability for international comparison Suitability for comparison over time Feasibility of aggregation

Core criteria:

1. Content validity: the indicator should actually measure the phenomenon that it claims to measure (Billiet and Waege, 2003);
2. Comprehensiveness: coverage of exemptions, tax cuts and differentiated tax rates: many tax designs include exceptions, providing exemptions or tax reductions for part of the target group. A risk of erosion of the environmental tax impact then appears (Barde, 1997), which should be incorporated in the conclusions on the greening of a tax system.

Although we will not quantify the difference, we will consider content validity as more important than comprehensiveness.

Statistical criteria:

1. Data availability: including ease of collection, timing of the release of the data, and link with existing reporting or data gathering frameworks.
2. Suitability for international comparison: governments favour comparative statistics, enabling them to 'benchmark' themselves against neighbouring and other countries (Steiner-Khamsi, 2009).
3. Suitability for comparison over time: possibility to create time series with the data.
4. Feasibility of aggregation: governments are more interested in indicators on the whole national tax system than on individual taxes.

Considering the raison d'être of indicators (see section 4), one could argue that 'communicability' is a missing criterion in this list. While we acknowledge the importance of communicability, we choose not to take it into this evaluation framework, because elements of communicability are already present in the second, third and fourth statistical criteria, which entails the risk of overlap.

4 | The four types of indicators

As in other policy fields, policy makers in the environmental field make use of indicators for both framing a policy problem and designing adequate policies (KEI, 2005). They facilitate

understanding of complex societal problems and make it easier for policy makers to communicate about them.

Indicators for environmentally related taxation are examined in three divergent bodies of literature. First, they are studied in the field of environmental or sustainability indicators. Since the adoption of Agenda 21, the international action programme for sustainable development in 1992, the number of sustainability indicators programmes has exploded (Krank et al., 2010). Second, they are one category studied in the field of indicators on taxation (e.g. European Commission and Eurostat, 2013). However, publications only rarely use the combined insights of the environmental indicators and taxation indicators fields.[35] The third study field, environmental accounting, does integrate economic and environmental indicators.[36] The aim of environmental accounting is to monitor the economic impacts on the environment and the environmental impacts on the economy (Havinga, 2011). Starting from 2013, EU member states are required to report on the indicator 'Environmental Taxation by Economic Activity',[37] which is mainly used for intersectoral comparison within one country, but may also be useful for international comparisons.

In this section, we elaborate four types of indicators for the greening of a tax system: revenue-based indicators, single tax rates, aggregate tax-rate based indicators and the implicit tax rate on energy. We make a theoretical evaluation of the four types of indicators using the six evaluation criteria introduced above. Our findings are summarized in a later section (Table 4).

4.1 Revenue-based indicators

The 'greening of a (national) tax system' is usually measured using two indicators: the revenues from environmentally related taxes as a percentage of GDP, and the revenues from environmentally related taxes as a percentage of the total tax revenues for a country (European Commission and Eurostat, 2011).[38] Both indicators are shown in Figure 4.

[35] One exception is: European Commission and Eurostat (2001), which is a study on environmental taxes from a statistical perspective.

[36] Such as the UN-led System of Environmental-Economic Accounting (SEEA) or the National Accounting Matrix including Environmental Accounts (NAMEA).

[37] Regulation 691/2011 on European environmental economic accounts.

[38] The 'Environmental Taxation by Economic Activity' mentioned above is another example of a revenue-based indicator.

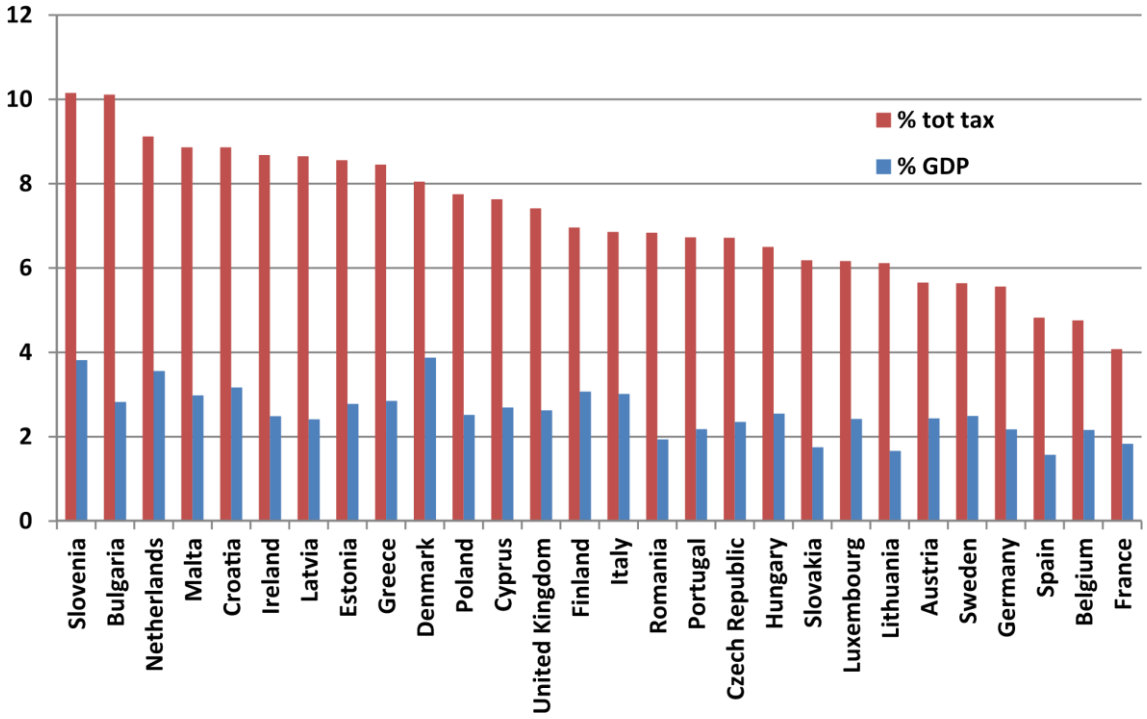

Figure 4. Revenues from environmentally related taxes in per cent of GDP and in per cent of total taxation, EU-28, for the year 2012

Source: European Commission and Eurostat (2014).

Both indicators have the advantage that the required data are gathered by almost all countries on a yearly basis, reported to both national parliaments and international institutions such as the European Commission, Eurostat and the OECD. Moreover, they are easy to aggregate and suitable for international comparison. Another advantage to the revenue data is that they reflect exemptions, reductions and differentiated tax rates: if a tax has a high rate but exempts the majority of the target groups, the tax will not heavily influence the revenue statistics.

Nevertheless, revenue-based indicators also have a number of important drawbacks, all of which are related to the validity of the operationalization of the greening of the tax system concept. An increase in environmental taxation revenues, whether in absolute monetary terms, in per cent of GDP or in per cent of total taxation does not necessarily correspond to a greening tax system (OECD, 2001). We distinguish four problems with that type of indicators. A first problem is that rising revenues can be the result of an increase in the tax base (European Commission and Eurostat, 2001; Laskowska and Scrimgeour, 2002), without any change in the design of the tax. Conversely, the design of environmentally related taxes can be made more environmentally-friendly without increasing revenues (OECD, 2010b). The indicator may rise or fall regardless of government decisions towards more or less emphasis on environmental considerations in the tax system. A second validity problem related to revenue-based indicators is that poorly designed environmentally related taxes, for example tax rates that do not reflect the environmental damage that they cause, may raise revenues without bringing about the desired behaviour change (OECD, 2010b). One example is the fact that diesel is taxed lower than petrol in most countries, while it should be vice versa taking into account environmental externalities (Mayeres and Proost, 2013). A third validity-related problem is that a country that historically has a lot of energy-intensive industry may raise significant revenue from that industry by

imposing a very low energy tax. The environmentally related tax revenues may be relatively high, while its environmentally related tax rates are low (OECD, 2010b). An often used example for that problem is Luxembourg, a country that combines a low level of environmental taxes with high concomitant revenues (Sterner and Köhlin, 2003). The explanation is that Luxembourg's low fuel taxes entail fuel tourism from all neighbouring countries, which is lucrative for Luxembourg's tax revenues, but at the same time has triggered criticism from the OECD for environmental reasons (OECD, 2010a).[39] As a fourth and final validity issue, the denominators of the two prevailing indicators from Fig. 1, GDP and total taxation, may also give misleading information (Bruvoll, 2009). GDP and total taxation revenues can rise or fall without any change in the environmentally related tax system. For example: most EU-countries have reduced their corporate tax rates between 1995 and 2011, by 12.2% on average (European Commission and Eurostat, 2012). Ceteris paribus, this means that the indicator environmentally related tax revenue as per cent of total taxation, will go up, although there has not been any shift in the environmentally related tax system.

4.2 Single tax rates

A tax system is a policy instrument which can be changed by tax authorities in many ways. One way is a change in the design of taxes; tax rates are a crucial feature of tax design. As a result, evolutions in (environmental) tax rates may provide more valid indications for the greening of a tax system than tax revenues (Braathen, 2012; OECD, 2001). This is illustrated by the OECDEEA database on environmental taxation[40], in which the OECD and EEA compare the diesel and gasoline tax rates internationally (see Figure 5).

[39] Fuel tourism accounted for 75% of total fuel consumption in Luxembourg in 2007 (OECD, 2010a, 111).

[40] http://www2.oecd.org/ecoinst/queries/, accessed April, 5, 2015.

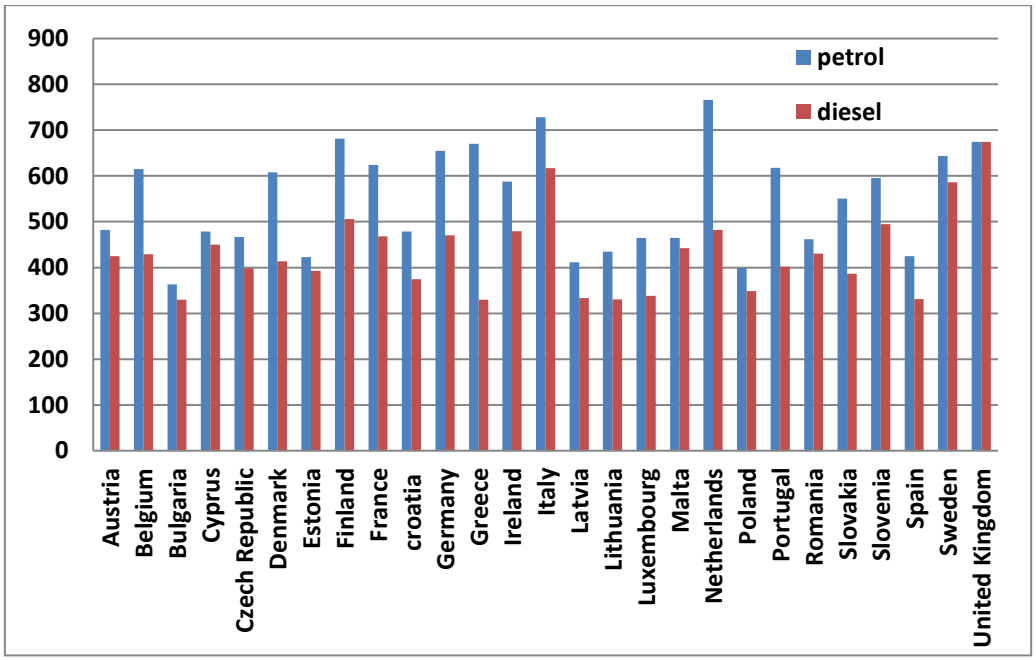

Figure 5. Tax rates for unleaded petrol and diesel fuel, EU-27, situation as at 1 January 2015 (EUR/1000 l) (VAT excluded)

Source: European Commission (2015).

The main advantage of single tax rates is the higher content validity for detecting greening of a tax system. However, it should be said that it is far from perfect. At least three validity issues need to be mentioned. First and foremost is the inherent weakness of this type of indicator: it gives an indication based on just one tax base, which makes it unsuitable for general conclusions about the greening of the national tax system. Second, very few environmentally relevant products or activities are taxed in a more or less uniform way throughout the EU or in the world, and even less have good and reliable data available. Consequently, international comparability may be a problem. Transport fuel taxes are possibly the only environmentally related taxes suitable for international comparison. And third, any differentiation in the tax rates, for environmental or other reasons, disturbs the comparability between countries. Even for the 'ideal' tax-rate based indicator, transport fuel taxes, and even for the EU member states that have to comply with the minimum rates and the design rules of the Energy Taxation Directive,[41] most member states apply differential rates, mainly related to the octane and sulphur levels of the fuels. Countries implementing a lower level for a more environmentally-friendly type of the fuel make their tax system more environmentally-adjusted but may be ranked lower in Figure 4 indicator as a result.

4.3 Aggregate tax-rate based indicators

In order to overcome the validity and aggregation weaknesses of the revenue-based indicators and single tax rates, we developed a new type of indicator.[42] A tax-rate based indicator is interesting from a validity point of view as tax rates give more information on the greening concept than revenues do (Braathen, 2012; OECD, 2001). Moreover, aggregation of such

[41] Council Directive 2003/96/EC, in effect since 1 January 2004.

[42] Building further on Bachus et al. (2006) and Bachus (2012).

indicators using a common denominator opens the door for indicators measuring the greening of a tax system on a macro-level, and for international comparison.

The aggregate tax-rate based indicators we propose take the shape of index numbers and they require weighting of components of the aggregated indicator. Those two elements are further elaborated in this section. We will further examine if a CPI-type of indicator (infra) can be used for our analysis. Two types of weighting methods will be explored, a Lowe and a Laspeyres index. Finally, the theoretical insights will be tested empirically using real data on tax rates and tax revenues for Flanders. With this analysis we aim to examine whether the choice of an index number type matters when analysing the greening of a tax system.

4.3.1 Index numbers

A composite or aggregate index number 'aggregates detailed information on prices and quantities into scalar measures of price and quantity levels or their growth' (Diewert, 2008). The Consumer Price Index (CPI; often used for measuring inflation[43] (ILO et al., 2004)) is the best-known example of a composite index number. The aggregation is done by taking the (weighted or unweighted[44]) mean of the tax rates. The simplest indexes use equal weights and arithmetic means ('Dutot index') or equal weights and geometric means ('Jevons index') (Silver and Heravi, 2007). However, a weighted index number clearly is to be preferred over an unweighted one, as it avoids that relatively unimportant items get the same weight in the index number as important items (ILO et al., 2004).

4.3.2 Weighting

In the process of gradual development and improvement of index number theory, it was Keynes (1930) who pointed out that price movements should be weighted by their economic importance. Similarly, if tax rates are weighted according to their importance, content validity grows, and the aggregated indicators will be more valid indicators for the greening of a tax system.

Weights (or 'importance' as we called it in the previous paragraph) can be chosen taking into account the specificities of the tax category. For example, for the tax on heating oil, the share of that type of oil in the energy mix can be selected as the applicable weight of that tax rate in the global tax-rate based index (Bachus and Defloor, 2011). Another possible weight can be the government revenues that are generated by the tax. That approach shows strong similarities with the Consumer Price Index (CPI) approach, which uses consumer expenditures to measure price evolutions. The CPI approach is suitable for following tax rate evolutions, using government expenditures as weights, since tax rate and price evolutions can be studied in a similar way. The CPI uses a basket of, mostly about 500–1000, consumer products. Expenditures are used as weights to distinguish between economically more and less important products (ILO et al., 2004).

[43] Although the CPI does not include producer prices, which makes it an incomplete measure for inflation (ILO et al., 2004).

[44] Adding no weights actually means using equal weights.

The CPI weighting approach can be followed for environmentally related tax rates. We will use government revenues[45] as the weight factor distinguishing between important and unimportant taxes. The tax rate on petrol and diesel will then be given a much higher weight than, for example, a tax on plastic bags, as the latter raises very low government revenues. In that approach, energy taxes will heavily influence the global tax-rate based indicator, which is appropriate since they represent the majority of the environmentally related tax revenues: 75% in the EU (European Commission and Eurostat, 2014).

4.3.3 Laspeyres and Lowe indexes

Index number theory has a vast body of literature which has developed over the last two hundred years. In our analysis, we take two types of indexes and explore their use as indicators for the greening of the tax system. Both index numbers use the government revenues of the environmentally related tax as weight factors, but as it takes some time before the details of the tax revenues are published, we need to explore different approaches. The first one is the Lowe index (P_{LO}), which is actually the type that is used in most CPIs. A Lowe index can be weighted by any set of quantities (ILO et al., 2004), which makes it possible to combine the tax rates of the current year with the government revenues of two or more years ago. The Laspeyres index (P_L) is less flexible, since only the tax revenues of the price reference year can be used as weights (Hill, 2008).[46] For example, taking one environmentally related tax, for which we want to compare the 2013 (p_{2013}) with the 2012 (p2012) tax rates,[47] knowing that the revenue for the tax in 2012 was $p_{2012}*q_{2012}$, p_{2013} should be divided by p_{2012} and multiplied by the weight, which is the share of the 2012 revenue for that tax in 2012, or $p_{2012}*q_{2012}$, divided by the total environmentally related tax revenue for 2012. The summation of these terms for all the environmentally related tax rates in the index leads to the aggregate Laspeyres index. The formulas of both indicators are:

Lowe: $$P_{Lo} \equiv \frac{\sum_{i=1}^{n} p_i^t q_i}{\sum_{i=1}^{n} p_i^0 q_i}$$ Laspeyres: $$P_L = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0}$$

The advantage of the Laspeyres index number is that the tax rate level of a certain year is weighted by the revenues for that same tax in the price reference year, which makes it the most accurate measure of the importance of a certain tax in a certain year. However, in practice, it is mostly not possible to construct the index for the current year, at least not as long as the previous year's detailed revenue statistics have not been published. This is a significant downside considering the fact that this kind of index numbers are primarily a policy tool, and politicians are looking for the most recent and updated information for preparing their decisions.

[45] Government revenues are the equivalent of the consumer expenditures in the CPI; moreover, they are easier to measure, as government has to report about its revenues and expenditures in great detail, while consumer expenditures are a diffuse source of information, which data have to be gathered by using surveys.

[46] The Laspeyres index is one special case of the (more general) Lowe index.

[47] This means that 2012 is the price reference year.

That is why the Lowe index comes in as a possible replacement, using the revenue data from the year n−2 as weight factors.[48] Therefore, yielding slightly on content validity by using a Lowe index may be justified for policy or statistical reasons. The Lowe index can be made available for policy makers instantaneously, for instance, in January 2016 for reflecting the situation of January 2016. Below, an empirical study is carried out to test the hypothesis that the difference between the two types of index numbers will be limited if used for measuring the greening of a tax system. If that hypothesis is confirmed, the Lowe index can be used for our type of analysis. If the hypothesis is rejected, policy makers should only use the Laspeyres index for measuring the greening of the tax system.

4.3.4 Chained Laspeyres and chained Lowe

The above described Laspeyres and Lowe indexes are fixed base indexes, which means the weights, once chosen, are not updated each year. That is the way most countries calculate their CPIs: a basket of products is selected and will last for about seven years, during which period the same basket (and the same expenditure data) is used as weights. After that period, a large update takes place, discarding certain products and adding others. This type of indicator becomes progressively out of date, especially when examining long time series, like in the empirical example we will show in the next paragraph, spanning the period from 1993 until 2011. The solution to that problem is to work with chained Laspeyres and Lowe indexes. Whereas a fixed base index calculates only one index covering, for example, the whole period 1993–2011, a chained index typically consists of the computation of (in this case) 18 subsequent indexes. These 18 outcomes are then multiplied with each other to get the chained index (Balk, 2010). Although the spread between the different indexes depends on different factors such as the price and quantity fluctuations, according to Hill (2008), the quantity reference period should be updated as frequently as possible, or, in other words, the indexes need to be chained.

In the next paragraph we will apply these theoretical and methodological insights to environmentally related taxes in an empirical case study.

4.3.5 Empirical testing: creating chained Lowe and Laspeyres indexes for Flemish environmentally related taxes

As shown by ILO et al. (2004), the choice of an index number may strongly influence the conclusions regarding the evolution of prices or tax rates. Even between two types of indexes as closely related as the two we study, the conclusion can be very different. Differences between the two indexes increase with the variance of the price relatives and with the amount of fluctuation in the prices or tax rates. Moreover, the choice between a chained and a fixed base index can also entail a spread between the results.

For that reason, we take both types of indicators, Laspeyres and Lowe,[49] both fixed base and chained, in our empirical analysis. We construct a new CPI-like type of index number, containing eight environmentally related tax rates applied in the Flemish region of Belgium.[50] The main

[48] Or even from an earlier year if necessary; any year's revenues can be used as weights in case of a Lowe index.

[49] We remind our earlier statement that a Laspeyres index is in fact one particular case of a Lowe index.

[50] Flanders is the most populated subnational region in Belgium, with around six million inhabitants, out of eleven million in Belgium.

objective of this exercise is to test the hypothesis mentioned above, stating that, as fluctuations in environmentally related tax rates are rather smooth, the spread between different indexes should be limited. Only if that hypothesis is rejected, the Lowe index is a fully-fledged alternative for the Laspeyres index when using composite tax-rate based indicators for measuring the greening of a tax system.

Our test case is based on real data on a basket of eight environmentally related taxes applicable in the Flemish region,[51] and spans the period 1993–2012.[52] We selected the eight taxes based on two criteria. The most important selection criterion was that the selected taxes should raise important government revenues: the eight taxes together accounted for about 90% of the total environmentally related tax revenues allocated to Flanders. The second selection criterion was the presence of at least one tax of each major group of environmentally related taxes: energy taxes, transport taxes and other taxes.[53] We selected the following taxes:

1. Excise tax on diesel as a motor fuel;
2. Excise tax on unleaded petrol (95 RON);
3. Elia tax: supplementary tax on electricity consumption;[54]
4. Yearly traffic tax;
5. Car registration tax;
6. Eurosticker: lump-sum yearly tax for heavy trucks;
7. Drinks packaging levy;
8. Flemish waste water levy.[55]

Three of these eight (1, 2 and 7) are federal taxes; the five remaining taxes are the competence of the subnational regions. Four taxes (1, 2, 4 and 8) were already in place in the base year 1993; the other four were introduced more recently. Only one tax (3) was abolished before 2012; the others were still in force at the end of 2012. Taxes 1 and 2 raised the highest revenue by far: together they accounted for 67% of the total revenue of the eight taxes in 1993 and for 62% in 2010.

The indexes we computed go back to quantity data that precede 1993: the Lowe index we constructed uses, for both the chained and the fixed base version, data going back to one year before the base year, so as far as 1992. Table 3 shows the four calculated indexes for the basket of eight Flemish environmentally related taxes.

[51] Three of these eight are Belgian federal taxes; the five remaining taxes are the competence of the Flemish region.

[52] The year 1993 was chosen as the base year for reasons of data availability.

[53] In our 2011 study on the greening of the Flemish tax system (Bachus and Defloor, 2011), we changed this typology somewhat, using four groups: (1) energy taxes (2) transport taxes (3) federal ecotaxes and (4) Flemish environmental levies. In this article, we will stick to that typology.

[54] Adopted to compensate Flemish municipality for their losses resulting from the liberalization of the energy markets.

[55] Until 2005, this levy was the Flemish environmental levy with the highest revenues in this category. However, subsequent reforms have gradually transformed this levy into a tax-deductible fee. As a result, its revenues have been declining since 2005.

Table 3. Four types of indexes measuring the greening of the Flemish tax system using aggregate tax-rate based indicators, 1993-2011[a]

	Fixed base		Chained	
	nominal	real	nominal	real
Laspeyres index	156,8	109,3	160,1	111,4
Lowe index	158,0	110,0	153,5	107,2

Source: own calculations based on Bachus and Defloor (2011), Belgian CPI used as deflator.

[a] The numbers in this table should be interpreted as follows: all the index numbers started at the value of 100 in 1993. By 2011, the (real) Laspeyres index had risen to 109.3 (9.3% increase), whereas the Lowe index had risen to 110 (10% increase).

Our hypothesis is valid, because the difference between the Laspeyres and the Lowe indexes is fairly small, especially compared to the example used in the ILO manual (ILO et al., 2004). This is not surprising since (1) according to index number theory, the spread between different indexes should be small in case of smooth tax rate evolutions (2) the Laspeyres index is one type of the more general Lowe index and (3) the Lowe index uses quantity data that is only one year earlier than the Laspeyres index. Our conclusion from this empirical test is that the Lowe index can indeed be regarded as a valid aggregate tax-rate based indicator for measuring the greening of a tax system. We name this new indicator the 'National Environmental Taxation Index'.

Our case study approach has one limitation that should be mentioned. Our chained indexes computed for Flanders could have been more dynamic, if we had adjusted the tax basket each year based on the revenue the taxes raised for that particular year. The result would have been that in each year, only existing, revenue-raising taxes would be in the basket. The fact that our sample of eight Flemish and Belgian taxes contained four taxes that were not in force yet in the base year 1993, may have led to an overestimation of the greening of the tax system, because those taxes rise from zero in the base year to a level later on that is obviously higher, which is a dramatic rise.

4.3.6 Assessment of aggregated tax-rate based indicators

The composite tax-rate based indicator type has a number of appealing features. The most important one is that it is based on tax rates, which is a more valid measure for the evolution of the tax system than government revenues. Thanks to the aggregation it becomes possible to integrate a large number of environmentally related taxes into one indicator, which increases the content validity as an indicator for a national tax system.

However, we see five remaining challenges related to this type of indicator. The first drawback is related to validity: different weighting factors can lead to different conclusions on the greening of a tax system (Bachus et al., 2006). As Jain and Sandhu (2009) state it "Index numbers are true only on the average".

A second downside of the aggregated tax rate approach is related to the introduction of new taxes. If new taxes are considered to have a zero value in the years before their introduction,

the effect of the new introduction on the index is disproportionally high. Conversely, if the new tax rate in year n is introduced at the value of the index in year n−1, the newly introduced tax rate has no influence at all on the aggregate index. As a middle course, assigning a value between the two extremes can be an option, but in any case the value or method chosen will affect the final result. In our case study, we did not address this issue of the substitution of taxes in the basket by other taxes, as our case was just aimed as an illustration of the use of indexes as tax-rate based indicators. Future research should elaborate on the issue of substitution of taxes in the basket, which is also a delicate and difficult point in index theory in general and CPI construction more in particular (see, among others, ILO et al., 2004).

A third problem is that international comparison, although possible, is an intense exercise which requires in-depth knowledge on the studied tax systems beyond the easily accessible statistics. Data availability can thus be considered as a fourth complicating factor for the use of aggregate tax-rate based indicators. A fifth issue is comprehensiveness. The aggregate tax-rate based indexes only take into account 'standard' tax rates. However, many tax regimes make abundant use of exemptions, tax cuts and special conditions and rates.[56] A high tax rate may turn out to be less significant if many of the tax payers are exempt from it. Moreover, tax schemes increasingly make use of differentiated tax rates, which is also hard to grasp with tax-rate based indicators. However, that problem is partially undone if environmentally related taxes revenues are used as weight factors.

4.4 Implicit tax rate on energy (ITE)

The European Commission and Eurostat (2011) define the implicit tax rate on energy as 'the ratio between total energy tax revenues and final energy consumption'.[57] Energy consumption is expressed in tonnes of oil-equivalent. Hence, the indicator measures how heavily taxed one tonne oil-equivalent of energy consumption is. The indicator is reported for the EU on a yearly basis (European Commission and Eurostat, 2014), as is shown in Figure 6.

[56] By way of illustration: the total government revenue forgone due to tax expenditures in Belgium has mounted up to more than 20% of total tax revenues in 2010 (Belgische Kamer van Volksvertegenwoordigers, 2011).

[57] A forerunner of this indicator was the 'effective tax rate', which did not refer to energy but to CO_2 emissions (National Statistical offices in Norway, Sweden and Finland & Denmark, 2003).

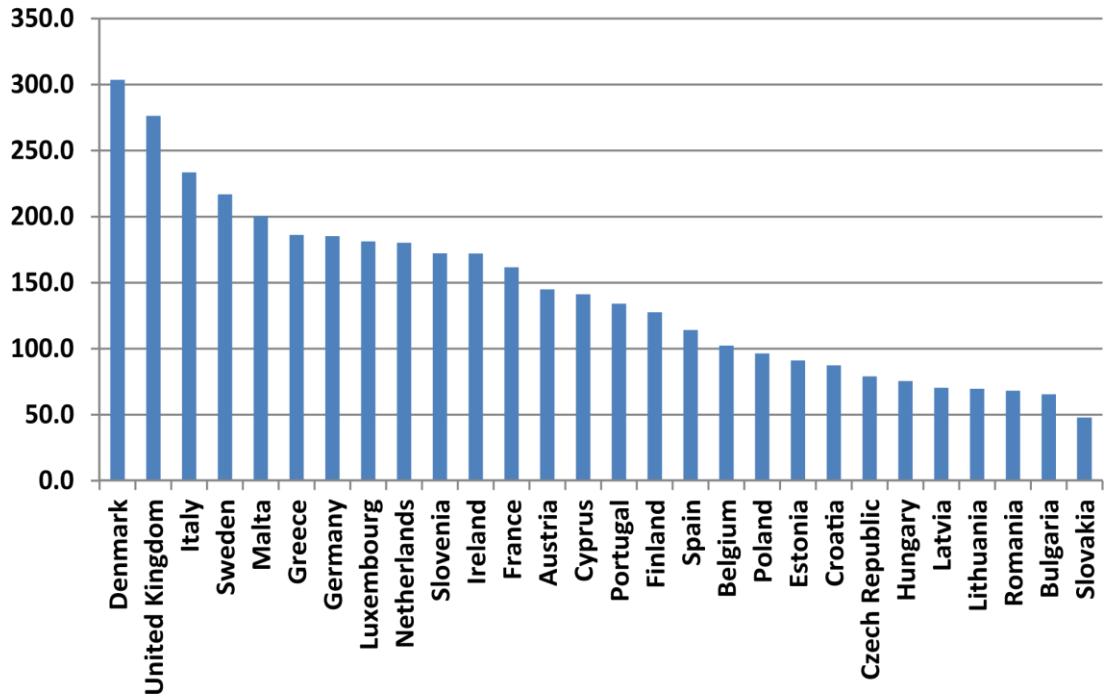

Figure 6. Implicit tax rate on energy, EU-28 (2012), in EUR per tonnes of oil equivalent, deflated (base year 2000)

Source: European Commission and Eurostat (2014).

This indicator combines the advantages of the revenue-based indicators (easy aggregation, data availability, covering exemptions and comparability) and the tax-rate based index numbers (higher content validity). Therefore, the implicit tax rate on energy indicator has high content validity, but of course it only measures one of the components of environmentally related taxes.[58] Unfortunately, 'the implicit tax rate for environmental taxes overall' cannot be constructed for lack of a common denominator.[59]

4.5 Empirical comparison of the four types on indicators

In this paper we explored four types of indicators for measuring the greening of a tax system. The tax-rate based indicator is an index in itself, but the other three types can be converted into indexes as well in order to make an empirical comparison possible. Again, we will use data for Flanders; the comparison is shown in Figure 7.

[58] Energy taxes, which represent 75% of total environmentally related tax revenues in the EU (supra).

[59] It is, however, possible to calculate the 'implicit tax rate of (road) transport', using the number of vehicle-kilometers as the common denominator. This exercise has recently been done for Flanders (Belgium) (Bachus, 2013).

The figure illustrates some of the arguments we put forward in the theoretical analysis of the indicator types:

- The tax rate on diesel has a strong influence on the implicit tax rate on energy and on the aggregate tax-rate based indicator, in both cases due to the heavy weight of the diesel tax in the basket;
- Tax-rate based indicators, both single and aggregate, have the advantage of being available in very recent periods, whereas the revenue-based indicators have a delay due to data availability.
- The revenue-based indicator may overestimate the greening in the periods of rising fuel sales 2002–2009 and underestimate it in periods of falling fuel sales (2011);

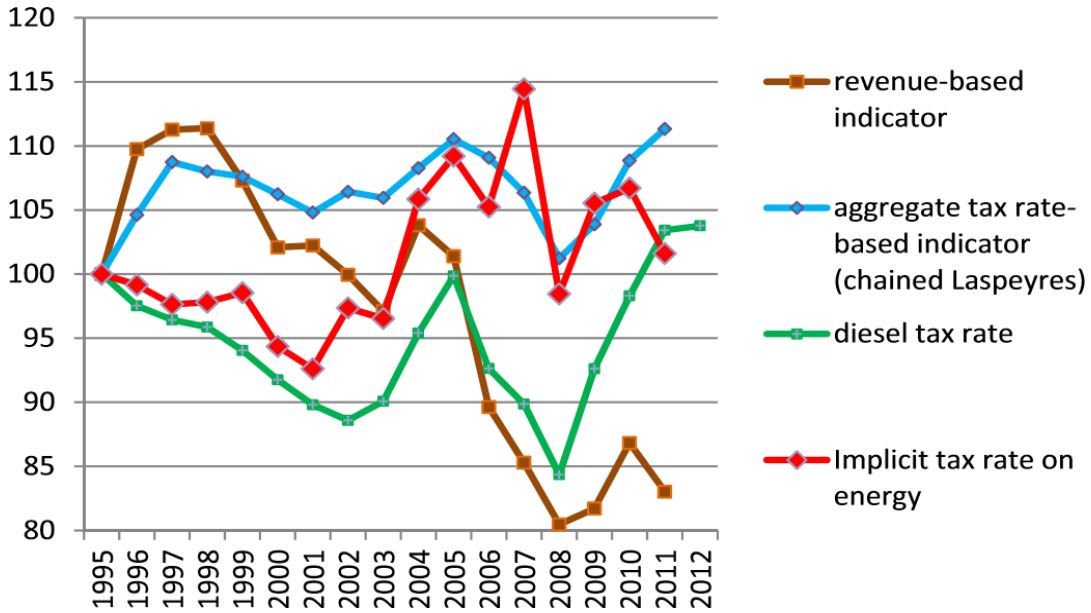

Figure 7. Empirical comparison of the four types on indicators for Flanders, 1995–2012, real indexes with base year 1995

Notes: Aggregate tax-rate based indicator is the chained Laspeyres index; the single tax-rate based indicator is the real tax rate on diesel transport fuel. Source: own calculations, based on Bachus and Defloor (2011) and Bachus (2013).

In order to separate signal from noise, policy makers using these four types of indicators should be aware of the potential distortions linked to each type of indicator. Energy use statistics may be added to the analysis to draw coherent policy conclusions. For the Flemish case study, interpreting the results in this way would lead to the conclusion that the revenue-based indicator underestimates the greening of the tax system, and the greening is more likely to have been slightly positive between 1995 and 2011.

5 | Overview of the evaluation results

In the previous paragraph, we presented a theoretical and qualitative assessment of the four types of indicators. There suitability for measuring the greening of a tax system was tested, using the six criteria mentioned in section 3. Table 4 summarizes the results of that exercise using an ordinal scale. The scores are allocated based on the qualitative arguments developed during the theoretical exploration and on the empirical testing[60]; the comparison of the scores between indicators should be interpreted with caution as they are subject to the author's interpretations.

Table 4. Summary of the assessment of the four types of indicators

	Content validity	Comprehen-siveness	International comparability	Comparability over time	Possible to aggregate	Data availability
Revenue-based indicators	-	++	++	++	++	+
single tax rates	+	-	+/-	+/-	--	+
Aggregate Tax-rate based indicators	+/-	-	+/-	--	+	-
Implicit tax rate on energy	+	-	++	+	+/-	++

Notes: ++ very good for this criterion; + fairly good; − fairly weak; – very weak.

Revenue-based indicators have excellent scores for statistical criteria and for comprehensiveness but suffer from low content validity, which is considered to be the most important evaluation criterion (supra). Single tax rates have a higher score for content validity but the lack of aggregation options and the fact that exemptions and preferential tax rates are not covered are disadvantages. Aggregate tax-rate based indicators are hard to use (comparability, data availability), and moreover have a number of important drawbacks related to content validity and comprehensiveness as well. Finally, the implicit tax rate on energy has many advantages but provides no information on transport taxation and most environmental levies.

6 | Conclusion

In this paper we carried out a theoretical and empirical assessment of four types of indicators used for measuring the greening of the tax system. We developed an evaluation framework

[60] The empirical testing only contributed to one score: the content validity of the aggregate tax-rate based indicator.

containing core evaluation criteria, such as content validity, and statistical criteria, such as data availability. We found that each of the four types suffers from problems related to content validity. Revenue-based indicators give a distorted view because they are partly based on the pollution quantity. Tax-rate based indicators do not have that problem, but aggregate tax-rate based indicators can give a distorted view depending on the methodology for choosing weights and on the way of introducing new taxes in the indicator. The implicit tax rate on energy has less aggregation issues and single tax rates have none. However, the number of taxes used in these indicators is limited, which erodes content validity as well. On the other hand, each of the indicator types also has one or more strengths. Based on statistical criteria, revenue-based indicators seem well fit for their purpose. However, since that type of indicator has the lowest content validity, policy makers should be advised against using solely those indicators for policy conclusions.

The main conclusion of our analysis is that there is no single best indicator for measuring the greening of a tax system. The four types of indicators all have their own merits and deficiencies, and provide highly complementary information. The recommendation from our findings is that the best results are obtained by using a measurement model including all four types of indicators, without aggregating them. They can be used as an integrated measurement tool allowing for accurate (qualitative) judgement of the phenomenon of the greening of a tax system. Eliminating one of the indicator groups decreases the content validity to a certain degree. However, for practical reasons, it may be an acceptable option to limit the measurement tool to the three indicators that are readily available, being the revenue-based indicators, one or more single tax rates and the implicit tax rate on energy, as long as one is aware of and explicit about the potential loss of validity.

In this paper we developed a new aggregate tax-rate based indicator for measuring the greening of the tax system, based on a Lowe-type of index. We named this new indicator ‘the National Environmental Taxation Index’.

Future research may further enhance the application of index number theory on the measurement of environmentally related taxes. More specifically, a more in-depth investigation on the issues of weighting and introduction of new taxes in the aggregate tax rate-based indicator is advised for. Finally, further elaboration on the difference between environmental taxes and environmentally related taxes, and adding green design elements in non-environmentally related taxes to this discussion is expected to further increase the knowledge of the use of the tax system as an instrument for environmental policy.

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Paper 3

The use of regulatory taxation as a policy instrument for sustainability transitions: old wine in new bottles or unexplored potential?

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The use of regulatory taxation as a policy instrument for sustainability transitions: old wine in new bottles or unexplored potential?

The burgeoning literature on sustainable transitions links persistent environmental problems to the functioning of socio-technical systems. Conventional policy instruments, such as environmental taxation, are often rejected by transitions scholars but in-depth studies on their potential are scarce. This paper explores the potential of the instrument of environmental taxation for influencing sustainability transitions. The multi-level perspective (MLP) and the multi-phase perspective (MPP) from transitions thinking and the social practices approach are combined with the environmental economics theories of Pigou and Coase. Our analysis shows that the highest impact of regulatory taxation will be realized at the end of the take-off phase and in the acceleration phase of a transition. Although important barriers exist and many conditions apply, regulatory environmental taxation, especially as part of a smart policy mix, has more potential for contributing to sustainability transitions than hitherto assumed.

Keywords: sustainability transitions; environmental taxation; multi-level perspective; multi-phase perspective; policy mix

1 | Introduction

Environmental problems are of all times. Yet, the past two decades, climate change, air pollution, natural resource depletion and biodiversity loss have reached the status of worldwide persistent threats (Foxon et al., 2009). There is increasing consensus in the literature that common policy responses, which are in the main incremental, will not provide structural solutions to those problems (Elzen & Wieczorek, 2005). Transition theory links those challenges to socio-technical systems, which fulfil a societal function using technical components, infrastructure, regulations and networks of organizations (Geels & Kemp, 2000). A transition is a radical and structural change with economic, cultural, ecological and institutional developments taking place at different levels of the socio-technical system (Rotmans & Loorbach, 2009).

An important discussion in transition literature concerns the question whether transitions, niches and regimes can be governed, or even steered, in a (sustainable) direction. Most transitions scholars see an active role for government, but not in the classical way as the top-down commander who can steer at will using its toolbox of instruments (Paredis, 2013). Rather, government is seen as just one group of actors (Geels et al., 2004), who are part of the regime

but simultaneously shape its adaptive capacity (A. Smith et al., 2005). Government actors exert a substantial influence on the functioning of the socio-technical system as they often maintain and reproduce regime functions in an intensive manner (A. Smith et al., 2005).
To address the complexity and long-term focus (1-2 generations) of transitions, "existing policy instruments need to be combined with new approaches" (Elzen & Wieczorek, 2005). In addition to command-and-control instruments and communicative instruments, economic instruments are used in environmental policy (Howlett & Ramesh, 2003; Perman et al., 2003). Geels (2012) indicates, in the context of transport systems, that economic instruments can be used to enhance pressure on an unsustainable regime. Chappin (2011) applies simulation models to study the influence of carbon taxes on energy transitions. Although these studies point at the potential of taxation, the theoretical dynamics behind the impact of a tax on the transition process are not well understood yet, and available studies on the topic are scarce. This paper aims to contribute to the growing literature of transition governance by means of an exploratory analysis of the potential of taxation as an instrument to support sustainability transitions. We will do so by combining the literature on environmental taxation with the literature on sustainability transitions, and by identifying the conditions for a tax to have that potential. In our theoretical exploration, we will combine two heuristic frameworks from transitions thinking, the multi-level perspective (MLP) and the multi-phase perspective (MPP), with the neoclassical theory of Pigouvian taxation, which is the basis of environmental taxation theory.

Our focus is exclusively on regulatory (environmental) taxes. These taxes are designed to influence the behaviour of citizens or companies, in contrast to more traditional taxes that are designed to raise government revenues or to redistribute revenues (Avi-Yonah, 2007).

This paper is organized as follows. The multi-level perspective (MLP) and multi-phase perspective (MPP) are explained in section 2, along with other transition concepts. In section 3, an overview is provided of the theoretical foundations of regulatory taxation. Section 4 shows the results of the combination of the theoretical strands of transitions and environmental taxation. Section 5 is dedicated to the limitations and barriers to the potential of environmental taxation and in section 6 we draw conclusions and provide suggestions for future research.

2 | Transition theory: the MLP and the MPP

The *multi-level perspective* (MLP) on sustainability transitions distinguishes between three levels (Geels, 2004; Verbong & Geels, 2007). At the macro level, the *landscape* represents the external environment of the system. Changes at the landscape level influence the socio-technical system (Markard & Truffer, 2008). Examples of such developments are global warming, global economic growth, political crises or demographic evolutions (Geels, 2002). At the meso level, the *regime* is the dominant form of functioning in the socio-technical system (Avelino & Rotmans, 2009). The regime can be a dominant technology, institution, policy, practice or culture. At the micro level, *niches* present alternative (sustainable) technologies, institutions, policies, practices or cultures that cause disruptions in the functioning of the socio-technical system. By experimenting and growing stronger, niches can eventually overtake the role of the regime and install a new dynamic balance in the socio-technical system (Kemp & Loorbach, 2006; Loorbach & Wijsman, 2013). For example, learning effects from experiments with niche technologies such as photovoltaic energy and wind power in the energy system may make those technologies increasingly successful. After the growing phase they may also become cheaper than regime

technologies such as nuclear and fossil fuel power generation. Those niches exert pressure on the regime, which could, in combination with other pressures from the landscape, policies, market developments and cultures, lead to a replacement of nuclear and fossil fuel-based power by renewables, ending up in a new equilibrium that will be more sustainable than the previous one.

A transition presents a radical and fundamental change in the dominant structure, culture and practices of a socio-technical system (Loorbach & Rotmans, 2006). The *structure* of the system consists of institutional, infrastructure, legal and economic provisions that are inherent to the functioning of the socio-technical system (de Haan, 2010). *Culture* is regarded as the shared values, norms and perspectives, which may be cognitive, normative or ideological in nature, and which underlie the socio-technical system (de Haan & Rotmans, 2011). *Practices* are the routines, habits and procedures operated by the actors in the system, which interact with the structure and the culture of the system.

The change that is required for a transition will not come about in a linear way. Rather, periods of rapid and slow (or no) change can alternate (de Haan & Rotmans, 2011). This implies that there are multiple phases in a transition process. Loorbach (2007) describes four phases that together depict an ideal-typical transition process, the MPP. In the first phase, the pre-development phase, actors are engaged in experiments (Kemp & Loorbach, 2006). During the take-off phase, the second phase, the regime will show signs of destabilization and niches will get an opportunity to position themselves as a viable alternative (van der Brugge & Rotmans, 2007). Rapid structural and cultural changes in the socio-technical system become visible in the acceleration phase (van der Brugge, 2009). In the last phase, the stabilization phase, a new sustainable regime is established (Avelino & Rotmans, 2009).

Transitions are driven by various endogenous and exogenous developments. Exogenous developments are changes at the landscape level. Endogenous developments, on the other hand, are events occurring at the meso-level (regimes) and micro-level (niches). According to de Haan and Rotmans (2011), there are three groups of *conditions* for change: *tensions, stress* and *pressure*. Tensions are changes occurring at the landscape level threatening the position of the unsustainable regime. A regime that functions inadequately or inconsistently will experience stress, which can nurture the downfall of the regime. Regime pressure or selection pressure, finally, will appear when niches impose themselves on the regime's position by becoming viable alternatives or by making the regime's functioning obsolete. Regime pressure, along with the reactions of regime and niche actors, will create *patterns of change* (Frantzeskaki & de Haan, 2009). When tensions dominate, a *reconstellation* pattern will appear. Stress and pressure will result in the patterns of, respectively, *adaptation* and *empowerment*. When certain patterns chain together, they create transition paths (de Haan, 2010). Choices made in the past will affect the path along which transitions will move. Actors are confronted with path dependencies, which may turn into lock-ins. For example, the choice of the authorities of some countries to invest in nuclear power plants has created path dependencies in the energy systems of these countries, which function as lock-ins that prevent a breakthrough to an energy system based on renewable energy.

Two governance approaches within transitions science indicate that belief in classical policy solutions is limited. The two most well-known governance models in transition literature are *transition management* (Kemp & Loorbach, 2006; Loorbach, 2007; Loorbach & Rotmans, 2010) and *strategic niche management* (Hoogma, 2000). Both these governance approaches emphasise the difficulties in steering socio-technical change. Strategic niche management sees the main role of government in process management, creating room for niche experimentation,

making sure that the process is not dominated by certain actors, and in learning and facilitating other actors learning possibilities (Kemp et al., 1998). The other governance approach, transition management, departs from the same view, but presents a process management method for policy makers wishing to influence burgeoning transitions processes (Loorbach & Rotmans, 2006). Transition management has been criticised, mainly because the term 'management' seems to suggest that it is possible to steer transitions by "deliberate intervention in pursuit of specific goals" in a top-down way (Shove & Walker, 2007, p. 764). Although transition management scholars such as Loorbach and Rotmans develop a more nuanced perspective on the 'steerability' of a transition than the name 'management' suggests, they do assert that 'goal-oriented transitions', in which the policy goals guide the process, exist. This view is not shared by all transition scholars. For example, Dewulf et al. (2009) think that a multiplicity of theories is needed for addressing such complex issues as sustainability. Shove and Walker (2007) question the very starting point of transition management that it is possible to deliberately steer socio-technical system change in any direction.

Both strategic niche management and transition management focus on policies that are aimed at the level of the niches. However, they largely ignore that the destabilization of incumbent regimes can equally be a valuable strategy, because this could speed up the upscaling of niche technologies (Kivimaa & Kern, 2016). Policies discouraging certain niche technologies or practices can play a role here (Turnheim & Geels, 2012). Taxation will be further examined as a regime destabilization instruments, as the main subject of this paper. In addition, 'policy mixes for creative destruction' will be explored in section 4.2.

3 | Regulatory and environmental taxation

A basic idea in economics is that markets allocate resources in an efficient way. However, this thesis is only valid under the condition of the presence of well-defined and enforceable private property rights (Perman et al., 2003). If that condition is not met, the market is not capable of creating or maintaining a socially optimal or desirable situation, and market failures appear (Bator, 1958). One example of a market failure is the existence of external costs or environmental externalities (Perman et al., 2003). Externalities are "benefits or costs generated as an unintended by-product of an economic[61] activity that do not accrue to the parties involved in the activity and where no compensation takes place" (Owen, 2004, p. 129). Pollution resulting from production activities is a typical example of a negative externality imposed on citizens, because the victims of the pollution have no legal rights to claim any compensation for the damage suffered. To resolve this market failure, government can create *property rights* for 'an unpolluted environment' and give them to the victims, or even to the polluter. In the latter case, the polluter receives a 'license to pollute' a certain amount. Following *the Coase theorem* (Coase, 1960), depending on the specific circumstances, this situation will lead to an equally efficient outcome as compared to victim property rights. However, from an equity point of view, the two solutions generate entirely different outcomes, as in the one case it is the polluter who pays, and in the other it is the victim (Perman et al., 2003). In theory, the polluter and the victims

[61] Although non-economic activities can also create externalities, for example vandalism (negative) and having a bee house in the garden (positive).

could bargain and agree on a compensation for the damage based on the victim's or polluter's property rights, in which case government intervention becomes redundant (Coase, 1960). In practice, however, the large number of victims and polluters and the costs of bargaining often prevent an optimal outcome of private bargaining. In that case, government regulation, through the use of command-and-control instruments, economic instruments or suasion, is needed (Perman et al., 2003). In this paper, we focus on the use of taxation as a regulatory[62] policy instrument in response to existing market failures. Regulatory taxes aimed at environmental improvement are called environmental taxes.[63] An alternative name is Pigouvian taxation, after the 20th century economist Arthur C. Pigou, who developed the idea to use taxation to tackle externalities (Pigou, 1920). According to Pigou, an environmental tax equal to the marginal damage at the efficient pollution level maximizes allocative efficiency and welfare. The theory of Pigouvian taxation belongs to the neoclassical economic perspective, which assumes that economic agents act in a rational way according to their individual preferences in such a way that their utility (or profit for companies) is maximized (rational choice theory). Moreover, neoclassical economics assumes that preferences are fixed, as an exogenous factor, which was the dominant assumption until the 1990s (Arnsperger & Varoufakis, 2006). Then some economists changed the assumption into "[preferences are] fixed in the short run, subject to change in the long run" (Doyle, 2004). Others completely dismissed the notion of fixed preferences stating that individual preferences change as a result of past outcomes, and sometimes even rapidly and systematically (Van Boven et al., 2003).

In a first-best world with no uncertainty, regulatory taxes are *statically efficient* because the emission reductions are achieved while using a minimum amount of resources (Sandmo, 2000). They are *dynamically efficient* because taxpayers will be inclined to seek further reduction methods due to the fact that the undesirable behaviour remains taxed (Faure & Weishaar, 2012). In this theoretically ideal situation, a tax always leads to a more efficient solution than a licence or other command-and-control (CAC) type of instrument. However, if complexity or uncertainty is introduced, many authors criticize Pigou's theory on the optimal level of an externality tax. Although a complete review of this literature exceeds the scope of this paper, we present three of the most important critiques. First, Coase (1960) dismissed the idea that a tax equal to the marginal damage cost increases total welfare in all situations. When there is uncertainty about the marginal abatement cost curves of polluting firms, the comparison changes. Taxes keep the edge over CAC instruments when the (absolute value of the) slope of the marginal abatement cost curve is greater than the slope of the marginal damage curve. Conversely, when the marginal abatement cost curve is less steep than the marginal damage curve, CAC instruments are to be preferred to taxes (Baumol & Oates, 1988; Perman et al., 2003). Second, Baumol and Oates (1988) add that it is often hard to calculate the monetary value of the marginal damage of the polluting activity, in which case a standard may also be the recommended instrument choice. And third, in case of monopoly or oligopoly, the optimal tax rate may vary from lower to higher than the marginal damage (Ebert & von dem Hagen, 1998).

[62] We use the term 'regulatory' tax in the broad sense, following Meier's (American school) definition (1985): "Regulation is any attempt by the government to control the behavior of citizens". In the standard English school, this term is defined more narrowly as all prohibitions and obligations imposed by government (Vedung, 1998).

[63] As opposed to 'environmentally related taxes', a broader term introduced by the OECD (2001, 15), where it is the tax base rather than the objective that forms the definition: "*any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance*"

An important element in the discussion on the optimal tax rate is the price elasticity of demand, which is not static. The absolute value of demand elasticities tends to increase over time (Lipsey & Chrystal, 2007; Pindyck & Rubinfeld, 2009). The reason is that demand elasticity is in fact mainly determined by the availability of substitutes. Investment decisions are made with a long-term perspective, and in the long run, more options are available for developing new (clean) technologies than in the short run (OECD, 2000). For example, Sterner (2007) estimated that the demand elasticity of petrol and diesel in the long run is about three times higher than in the short run.

In addition to determining the correct tax rate, other tax design elements need to be decided. First, the tax base, which is the object that is taxed (Sandmo, 2000), needs to be chosen. This can be input products, output products, production factors (energy), production (processes, activities or techniques), consumption or emissions (Vollebergh, 2008; Weber, 2011). The most effective way of eliminating externalities is by choosing the externality itself (e.g. CO_2 emissions) as the tax base (OECD, 2010). In practice, emission measuring problems often hinder direct taxation of emissions. *Proxies*, such as petrol sold as a transport fuel, then form alternative tax bases (Dias Soares, 2011). Second, tax rates can be differentiated (Määttä, 2006), in which case certain products, processes or groups of taxpayers are granted a lower tax rate or are exempt from the tax. Third, a tax can be implemented at one specific moment in time or in multiple phases whereby the tax rate is raised or reduced in each phase.

4 | The (in)compatibility of environmental taxation with transition theory

In this section, we first analyse the compatibility of environmental taxation with transitions thinking theories by discussing positive and negative arguments for the use of taxation in sustainability transitions science (section 4.1). Next, we explore the use of environmental taxation in the main elements of socio-technical systems, structure (4.2), culture and practices (4.3). The latter two are treated together as they are intertwined. The use of the MPP and the MLP is integrated in the analyses of 4.2 and 4.3; for the MLP this means that the use of environmental taxes for niches and regimes is explored without explicit reference to the MLP. The landscape level is not mentioned, as this is external to the socio-technical system and cannot be influenced by regime or niche actors in the short run (Geels, 2011).

4.1. (In)compatibility arguments

The transitions school sees public authorities as just one group of actors in a socio-technical system. They are an important actor, but they cannot steer a transition in a top-down way (Kemp et al., 2007b). Traditional policy-making models, including neoclassical economics, are mostly rejected based on the following four arguments. First, traditional policy-making is deemed unfit for dealing with high-complexity, long-term, wicked societal problems, because the knowledge on ecological cause-effect relations is often limited and political compromises inevitably lead to incrementalism as opposed to structural system change (Rotmans et al., 2005; Kemp et al., 2007b; Mathijs, 2008). Second, existing policies are the result of outdated legislation, routines and institutional relations and are characterized by path dependency and technological lock-in (Rotmans et al., 2005). Third, the view of neoclassical economics on the preferences of

individuals is too static, while instead a transition would require changing preferences (Kemp et al., 2007b). Finally, steering a transition towards sustainability involves a subjective interpretation of sustainability, which "should arise from a multi-actor process, involving a balanced diversity of stakeholders" (van der Brugge et al., 2005). Geels (2012) describes transitions as co-evolutionary processes, which require the involvement of many social groups. Network management in policy-making would be a step forward, but even those policy networks are not necessarily concerned with the long term (Kemp et al., 2007b).

Transition management is a governance approach based on transition theory, which proposes a bottom-up approach to steer a transition, based on multi-actor involvement. However, it does not offer a full-fletched alternative to traditional policy-making, as it is "not directly solution-oriented, but explorative and design-oriented" (Rotmans et al., 2005, p. 6). Therefore, some transitions scholars revert to other academic fields, such as *evolutionary economics* to analyse sustainability transitions and related policy strategies. Inspired by the field of biology, this field focuses on three central concepts: diversity, selection and innovation. Models from evolutionary economics can cope with complexity; they deviate from neoclassical economic theories by acknowledging that economic agent behaviour is explained by bounded rationality (van den Bergh et al., 2006b). People's rationality is bounded because of a lack of appropriate and reliable information, limited cognitive capacities and limited decision-making time (Simon, 1955; Kahneman, 2003). Evolutionary economics leaves more room for environmental taxation than most transitions studies, although it emphasises the need for a combination of policy instruments or policy mixes. (van den Bergh et al., 2006a). The role of policy mixes for sustainability transitions is further treated in section 4.2.

So, if the neoclassical policy instrument of environmental taxation is so hard to reconcile with the bottom-up governance principles of transition theory, is it still worthwhile to study the combination? Four arguments support an affirmative answer. First, as we demonstrated in section 3, the impact of environmental taxation is much higher in the long run than in the short run, which gives this instrument an interesting appeal considering the fundamental long-term change transition theory describes. Second, when the economy is (threatening to get) stuck in a technology that is not serving the long-run transition goal, a regulatory tax on that technology may unlock (further) lock-in, thus avoiding an important obstacle for a sustainability transition (den Butter & Hofkes, 2006). Third, policy attention tends to go to supporting niches but much less to destabilizing the dominant regime, which is politically more difficult. However, according to Kivimaa and Kern (2016), niche support policies will need to go hand-in-hand with regime destabilization policies aimed at internalizing externalities. A tax on the dominant regime technology is particularly suitable for that purpose (Geels & Schot, 2007). Fourth, the bounded rationality concept embraced by transition theory still incorporates a level of rationality, implying that a price signal may still have an effect.

We conclude that there is no consensus on the use of regulatory taxes to enhance sustainability transitions. Some scholars see a role for taxation, but rather as one part of a more comprehensive policy mix (Kemp et al., 1998; Geels, 2006; Markard & Truffer, 2008).

4.2. Structure

The roots of transition theory lie in a variety of academic fields, such as evolutionary economics, structuration theory, neo-institutional theory and science and technology studies (Geels, 2011). Technology is a key component of the structure of socio-technical systems. Although not all

technological innovations are sustainable, they can foster sustainability transitions if they are steered towards sustainable goals and applications (Alkemade et al., 2011).

Technological change can be presented visually by means of a technology life cycle model (TLC) developed in the literature concerning the management of technology (Gao et al., 2013). According to Ernst (1997), the technology life cycle is an S-curve consisting of four phases: research and development, growth, maturity and saturation. Sometimes a fifth phase, the decay phase, is added (Haupt et al., 2007). The TLC S-curve paved the way for the S-curve from the multi-phase perspective on transitions. Table 5 combines these two insights.

Table 5. Combination of the technology life cycle and the multi-phase perspective on socio-technical transitions

Phase	Technology life cycle	Transition process
Phase 1	Research and development	Pre-development
Phase 2	Growth	Take-off
Phase 3	Maturity	Acceleration
Phase 4	Saturation	Stabilization
Phase 5	Decay phase	---

Source: Gao et al. (2013) and Loorbach (2007)

No mention was found in the literature on any equivalent to the decay phase in transitions, but according to Grin et al. (2010, p. 129), “The end point of any transition curve may be the beginning of the next transition curve”, which is consistent with the theory of multiple, successive S-curves in the technological life cycle model (Utterback, 1996).

Regulatory taxes are implemented to reduce the price ratio between relatively cheap regime technologies and relatively expensive niche technologies (Bigano et al., 2000). The famous Porter hypothesis confirms that environmental regulation may entail innovation and this effect is stronger for environmental taxation than for command-and-control instruments (Mikael Skou Andersen & Ekins, 2009). A tax on the dominant regime technology will compensate for the low performance of the new technology in the early phases and for the fact that often the regime enjoys benefits such as enabling infrastructure and legislation. A tax levels the playing field (Kern & Smith, 2008), which indirectly allows the sustainable niche(s) to become more competitive, to grow and eventually to take over the role of the dominant regime. According to Popp (2006), a carbon tax in combination with R&D subsidies yield the best results for climate technology development. A stand-alone tax could also reach 95% of that result, while an R&D subsidy alone would realize only 11% of that result.
Moreover, a tax generates revenues which can be used for favouring the preferred niche even more, by providing subsidies to R&D or environmental projects (OECD, 2001). Note that the removal of existing subsidies to the regime technology can have the same impact as taxing it. For reasons of policy coherence, it is advisable to remove regime subsidies before introducing new taxes.

But in which phase of a transition should regulatory taxes be introduced to destabilize the regime technology? In the early stages, technology development is a creative process, which needs stimulation (subsidies) to widen the playing field rather than restrictions from a negative instrument such as a tax. According to Taylor et al. (2005), regulatory taxes are most effective in the *commercialization phase* of an environmental technology. In the MPP, this period of commercialization corresponds to the end of the take-off phase and the acceleration phase in the transition process. This implies that a regulatory tax should be aimed at supporting the upscaling of sustainable niche technologies. This conclusion is illustrated graphically in figure 8.

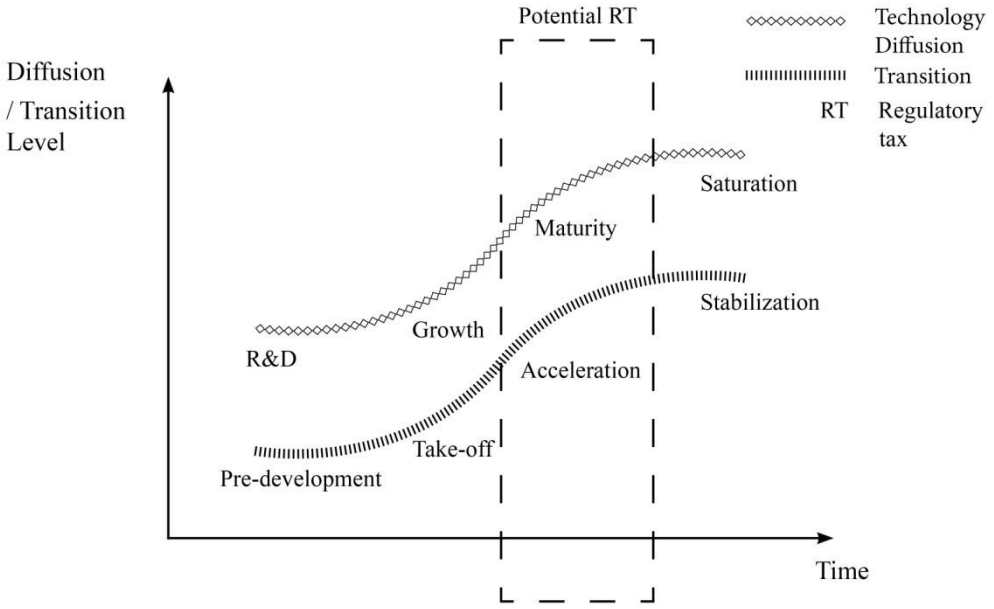

Figure 8. Regulatory taxes and technologies

Source: Bachus and Vanswijgenhoven (2015)

Essential for a transition to unfold is *co-evolution* between the aforementioned technologies, norms and social practices (Elzen & Wieczorek, 2005; Kemp et al., 2007a). Kemp and van Lente (2011) acknowledge the fact that not only technologies need to change, but also the way people use them. Early adopters of a new technology may want to set a new social norm by adopting, but this may not be followed by late adopters, who generally need more incentives to adopt the technology, such as a regulatory tax (Bosshardt et al., 2013). Co-evolution will not be served optimally by the introduction of an isolated environmental tax. Instead, smart policy mixes can accelerate both regime destruction ('creative destruction') and niche upscaling (Kivimaa & Kern, 2016). Policy mixes contain not only a mix of instruments but also policy strategies and policy processes. They need to be designed taking into account criteria such as consistency, coherence, credibility and comprehensiveness (Rogge & Reichardt, 2016).

In the stabilization phase, which may converge with the decay phase of unsustainable old regime technologies, a few actors keep on using the old technology. To accelerate the phase-out, the existing regulatory tax may be gradually increased or – eventually – replaced by a ban.

An important comment is that both evolutionary economics and transition theory are warning governments not to create lock-ins. Policy makers are advised not to start supporting niche technologies until they have sufficient indications regarding the system change potential of the technology (Kemp et al., 2007b). Furthermore, in the early phases, diversity should be pursued by supporting multiple niche technologies (Geels, 2006). The risk of creating a lock-in is much smaller for a tax than for a subsidy, as it is easier to know which dominant regime technology is undesirable in the long run (e.g. fossil fuels in the energy system), than to know which niche is the most desirable one for the long-term transition. However, the introduction of a regulatory tax equally requires careful timing. If the tax is introduced in a phase where the sustainable niches are not mature enough to take over the role of the regime, the system does not provide for sufficient substitutes, which may lead to a system breakdown (van der Brugge & Rotmans, 2007).

4.3. Practices and culture

At first sight, the link between environmental taxes and practices seems rather obvious. Regulatory taxes can be imposed on unsustainable regime practices, with the aim to create behavioural change and favour the more sustainable niche practices. According to neoclassical economics, this strategy will be both effective and efficient in many situations (see section 3). However, the neo-classical assumption that the individual makes a rational choice by comparing benefits and costs, is subject to much criticism. Several schools that study consumer and citizen behaviour point to occasions where citizens do not display the predicted behaviour. One explanation, according to behavioural economics, is people's bounded rationality (see section 4.1).

Explaining behaviour from an environmental perspective has long been dominated by econo-socio-psychological models based on rational choice theory, which look at the individual agent and his beliefs, attitudes and values as the main determinants of behaviour. More recently, a new approach developed by Reckwitz (2002) and Spaargaren (2003), the social practices approach, building on Giddens's (1984) structuration theory, takes a more balanced position between agency and structure by focusing on the daily practices, such as washing or buying food, instead of on the individual or his environment. Within this theoretical framework, Shove and Pantzar (2005) define practices as *entities*, which consist of three elements: materials, competence and meaning (Shove et al., 2012). Materials are objects, tools and infrastructures. Competence consists of knowledge and skills that are "embodied in people and things" (Watson & Shove, 2008). Both materials and competence contain similarities with the structure of a socio-technical system defined by transition researchers (de Haan & Rotmans, 2011). Meaning consists of cultural conventions, expectations and socially shared meanings (Røpke, 2009; Spurling et al., 2013). Although the theory of social practices does not explicitly dwell on the concept of culture (Ortner, 2006), the description of meaning comes close to the definition of culture presented by transition researchers (Frantzeskaki & de Haan, 2009).[64]

Rational choice-based economic and psychological models translate theory into (environmental) policy in a straightforward way: an economist will propose to intervene by changing relative prices through taxation, while a psychologist will propose to sensitize people and focus on their motivation and attitude. Transition theory opposes these rational choice-based approaches by

[64] For instance, the practice of using the car to buy groceries consists of (1) the materials used, in this case a car and fuel, (2) competence, the skill of driving a car and (3) meanings, we perform this action to get all our groceries in one haul. This practice is reproduced by a large number of individuals.

putting forward a heavily bounded rationality and a strongly context-determined view[65] (Shove, 2012), which limits the role of instruments and even of public authorities. The social practices model is equally critical towards the impact government can have on people's behaviour, because "practices have lives of their own" (Shove, 2012), and the impact of government interventions will be unstable and unpredictable. Impact is possible, however, but only by trying to change the conditions for (un)sustainable practices, their meanings, materials and competences. Public authorities can bring about strategically important changes that may influence the reproduction of practices (A. Smith et al., 2005). While pursuing this, policy makers may use similar instruments to the ones in place today (Shove, 2012), which include regulatory taxation, albeit selectively. Regulatory taxes thus help to promote *co-evolution* of materials, competence and meaning (Shove, 2003), leading to a reduction of unsustainable practices.

Combining transition theory with the social practices theory may be thwarted somewhat by the limited role transition theory sees for agency (A. Smith et al., 2005). However, Geels (2011) does not agree with this criticism. He claims agency is fully integrated in the MLP in the form of bounded rationality, which clears the way for combining the social practices model with the MLP (figure 9), following the example of Crivits and Paredis (2013).

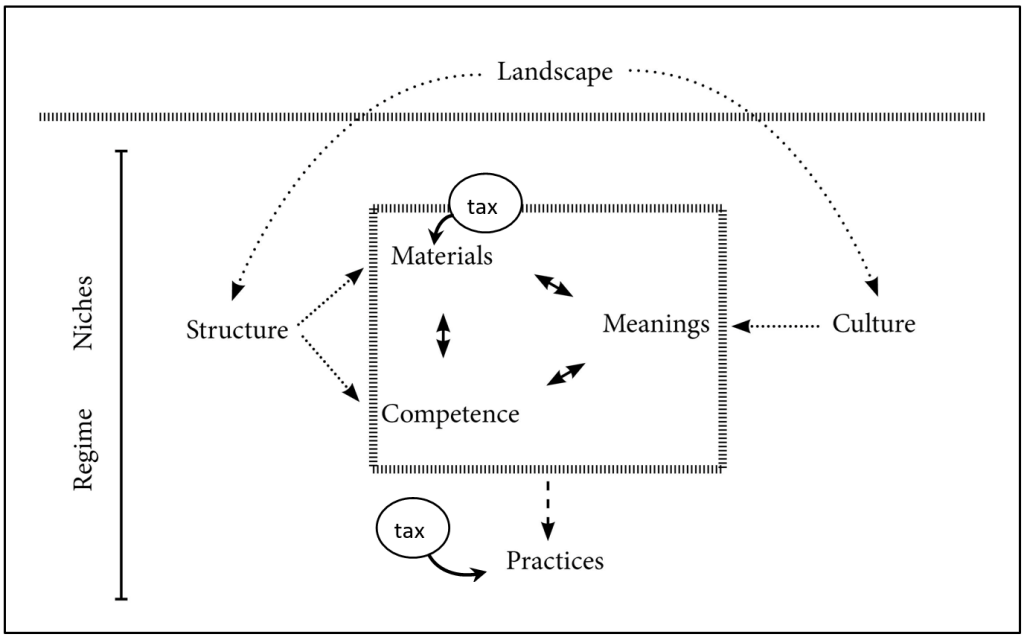

Figure 9. Integrated framework of social practices approach and transition theory

Source: own interpretation of Shove and Pantzar (2005) and de Haan and Rotmans (2011).

Figure 9 shows that taxes can be applied directly on the unsustainable practices[66], as they are the central drivers of behaviour (Hargreaves, 2011). However, they can also be levied on the conditions for (un)sustainable practices; the materials seem the most logical tax base (such as a tax on fossil transport fuels or wood stoves), because materials are often priced and sold on markets. For competence and meanings, this is much less the case, which makes them less

[65] Although the specific transition governance approach called 'transition management' puts forward a more agent-based perspective, it still emphasises the existence of landscape elements that can hardly be changed.

[66] For example, the congestion charge for anyone driving a car into London during peak hours.

suitable as tax bases. Taxing practices and their conditions could entail co-evolution of technology, norms and social practices, which can drive sustainability transitions (Brown et al., 2013).

The concept of culture is intertwined with practices (Geels, 2004) and is therefore already largely included in the discussion, although cultures change more slowly than practices (Rotmans, 2003). Cultural change will come either from outside the socio-technical system (landscape changes) or from changing practices. Finally, including the multi-phase perspective in our analysis of practices and culture, the conclusion that regulatory taxes have a much larger impact in the long run than in the short run, remains valid. Unsustainable regime practices can be taxed in any phase of a transition, but again, alternatives need to be available, which implies that taxation will have a higher impact in the (end of the) take-off phase and in the acceleration phase, which is a similar conclusion to the one in section 4.2 on structure.

5 | Limitations for and barriers to the potential of environmental taxes

Notwithstanding the moderately positive conclusions on the potential of environmental taxation for enhancing transitions, we identify six barriers and limitations that should not be overlooked. First, public and political support for environmental taxation is limited. People dislike taxes in general (Avi-Yonah & Uhlmann, 2009), and environmental taxation in particular because they see it as an illegitimate sources of revenue for the government (Green Fiscal Commission, 2009a). One way of making environmental taxation and green tax reform more acceptable is using insights from behavioural economics. For example, to make people accept a budget-neutral tax reform, the value of what they receive should be higher than the value of what they sacrifice. This phenomenon is called the endowment effect (Kahneman et al., 1991). Second, an environmental tax in a socio-technical system such as the energy system will need to be implemented for a long period (more than ten years) before it starts living up to its potential, for both technology and practices. However, politically this is a long period, and the environmental tax reforms that survive the first political decision process, are often reversed when a new government takes office. This happened to the Australian carbon tax in 2013 (Carl & Fedor, 2016). A rare counterexample is the Swedish carbon tax, which has been in place since 1991 (Daugbjerg & Svendsen, 2003). Third, choices made for or against a certain technology or practice will influence policy options in the future (path dependencies) (Rotmans, 2003). Misalignment of a tax with the transition vision could result in a lock-in or even system breakdown (van der Brugge & Rotmans, 2007; Kemp & Pontoglio, 2011), although a subsidy poses a larger risk of a lock-in than a tax. Fourth, the lack of sufficient, appropriate or promising niches is a barrier, because niches that do not perform consistently will not provide any benefits (Sopha et al., 2013). Fifth, environmental taxes could have some undesired side effects, such as a negative competitiveness impact and a regressive impact. However, those deficiencies can be largely redressed by careful design and compensating measures as part of a green tax reform (Mikael Skou Andersen & Ekins, 2009; Klenert & Mattauch, 2016). Finally, sixth, a stand-alone policy instrument, taxation or other, will always have a number of downsides, part of which can be overcome by using smart instrument and policy mixes (Oikonomou et al., 2014), such as an environmental tax in combination with a large communication campaign explaining the benefits

of the tax to citizens, and with revenue recycling, for example a subsidy, to increase public support.

6 | Conclusions and future research

Our theoretical exploration has brought forward that, although transitions are complex and the impact of government policy is often unpredictable, well-designed environmental taxes can contribute to a certain change in a desired direction. The highest impact of regulatory taxation will be realized on long-term technological change and on influencing social practices and their underlying materials. The neoclassical economic view on taxation over-emphasizes rationality as a mechanism for explaining behaviour. However, the degradation of government, by transitions scholars, to just one actor of many, constitutes an underestimation of the impact government policy, including environmental taxation, can have. More specifically, environmental taxation can play a role in removing technology lock-ins and in creating pressure on the dominant regime technology or practice, particularly at the end of the take-off phase and in the acceleration phase of a transition. However, implementation may be considered earlier, as the impact will be limited in the short run and maximal in the long run.

Although we found some potential for the instrument of taxation, significant barriers were also identified, such as limited public and political support, path dependencies and side effects. However, some of these barriers can be overcome by focusing on the design and the success factors of environmental taxation. First, governments should study niches and regimes thoroughly before deciding which niches to support and which regime technologies or practices to destabilize using environmental taxation. Second, taxation should be part of a policy mix with complementary instruments, such as suasion. Flexibility should be enabled in the policy arrangements to make room for co-evolution of technologies, practices and cultures. Finally, broad political consensus should be sought for a green tax reform to last longer than one political term. These three policy recommendations can be combined into a more tangible policy mix, by including a remark on the revenues of environmental taxes. Studies on the acceptability of environmental taxation show that this instrument is very unpopular with the public, which is a major obstacle for its broader implementation (Baranzini & Carattini, 2017). However, public acceptability rises considerably when (part of) the tax revenues are earmarked, which means they are used for supporting environmental purposes (Kallbekken & Aasen, 2010). A promising policy mix could therefore consist of a budget-neutral policy package, combining four elements: support for niche experimentation space, an environmental tax, a concomitant communication campaign and an overarching policy process that is characterized by participation and co-creation with citizens.

With this paper, we aimed to make a contribution to filling the “pressing need to improve the understanding of the politics and the policies of sustainability transitions” (Markard et al., 2012, p. 962). We feel more research is needed in the future on the distinction between practices and culture within the transitions thinking school, on the best policy mixes for fostering sustainability transitions, and on gathering empirical evidence of some of the claims made in theoretical studies regarding the role of government and policy instruments in the field of sustainability transitions.

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Paper 4

"I'll accept it if you earmark it": towards an improved understanding of the acceptability of environmental tax reform

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Bachus Kris, Verhofstadt Elsy & Van Ootegem Luc, I'll accept it if you earmark it": towards an improved understanding of the acceptability of environmental tax reform, in review, submitted to Ecological Economics on 19/04/2017 (2016 IF: 2,965).

Abstract:

Although it is widely acknowledged that taxation is a powerful instrument for combating environmental problems, environmental taxation is still underused. Public acceptability of regulatory taxes appears to be low, to the extent that a trade-off between the acceptability and the efficiency of policy instruments can be observed. This paper examines the determinants and conditions for public support and willingness to pay for environmental taxation, based on survey data of 1308 citizens. The results show that education and environmental awareness are determinants for support, and that initial low support can be significantly improved by earmarking the tax revenues to the environment. Other ways of revenue recycling, such as an environmental tax reform (ETR), can be ranked based on acceptability. We call this ranking the 'Ladder of Acceptability of Revenue Recycling Options' (LARRO). Well-chosen design options for the environmental tax reform can further improve its acceptability.

Keywords:

Environmental taxation; Acceptability; Public acceptance; Public support; Environmental tax reform; Revenue recycling.

Highlights:

- There is a trade-off between the acceptability and the efficiency of policy instruments.
- We use survey data to examine the determinants for support for environmental taxation;
- Earmarking is crucial for obtaining public support for environmental taxation.
- We create the 'Ladder of Acceptability of Revenue Recycling Options' (LARRO)

1 | Introduction

Today it is widely accepted that taxation is a powerful instrument for combating complex environmental problems, such as climate change (Aidt, 2010). However, policy processes aimed at implementing environmental taxes often fail, for many reasons (Heres et al., 2013). The literature devotes quite some attention to the role of lobbying by NGOs and businesses in policy processes aiming at implementing environmental taxes (Cherry et al., 2014). However, another factor that is thought to thwart large-scale implementation of environmental (Pigouvian) taxation is public acceptability (Vandyck & Van Regemorter, 2014). Taxation as an instrument aimed at environmental behavioural change has always suffered from low acceptance with the public (Baranzini & Carattini, 2017). When the revenues of taxes are used for environmental spending or reducing other taxes, public support significantly increases but still remains limited (Hsu et al., 2008). Although the exact reasons for this aversion is still under study, factors found to have an impact include the perceived (low) effectiveness of environmental taxation, the coerciveness of the instrument and psychological factors such as fiscal illusion (Buchanan & Tullock, 1975; Baron & Jurney, 1993; Baranzini et al., 2014).

This paper first reviews the theoretical and empirical literature on the determinants of public support for environmental taxes (ET) and environmental tax reform (ETR). The difference between these two terms is that an ETR[67] adds how the revenues of the ET will be spent. Second, it draws several hypotheses from the literature to test new determinants to explain public support and to find more detailed evidence regarding existing claims. The data are drawn from a unique large scale quantitative survey on the acceptance of environmental taxation and environmental tax reform carried out in Flanders, Belgium. Third, the paper uses the empirical results to propose policy recommendations on how to overcome the acceptability barrier to environmental fiscal reform. This study exclusively focuses on acceptance by citizens, not by firms or other societal actors that may also influence policy-making.

In this paper, support, acceptance and acceptability of environmental taxation are used interchangeably with 'willingness to pay' (WTP). The term 'support' is used more often in social acceptability studies, while WTP in environmental economics is primarily used in the context of willingness to pay for improved environmental quality or less pollution. WTP can be regarded as an indirect measure of support for pricing policy instruments such as taxation (Ivanova & Tranter, 2004).

The paper first turns to the state of the art of the literature. It then proposes a number of hypotheses on the acceptance of environmental taxation (ET). It continues with a description of the survey carried out in Flanders, after which the results are presented. We end with conclusions, policy recommendations and ideas for future research.

[67] An environmental tax reform (ETR), or green tax reform, is the process of shifting the tax burden from employment, income and investment, to pollution, resource depletion and waste (OECD, 1997). An ETR consists of two components: an increase in ET, and a decrease in other taxes. Such a reform often (but not necessarily) aims at revenue-neutrality for the government.

2 | Theoretical and empirical state of the art

The topic of support for environmental taxation does not rely on a distinct theoretical school or model. Theoretical studies touching upon the issue build on various disciplines, including economics (neoclassical and Pigouvian theory, public choice theory, behavioural economics), political science (instrument choice theory) and psychology. The many empirical studies either draw their hypotheses from those theoretical strands or approach the topic in an ad-hoc manner, examining potential determinants of acceptability without clear roots in theory. A central concept for understanding (lack of) public support for environmental tax reform (ETR) is tax aversion. Because of its importance, tax aversion is treated in a separate section (2.1). In section 2.2, other relevant theories are elaborated and in section 2.3 we summarize the empirical literature on the acceptance of environmental taxation (ET).

2.1 Tax aversion

Several large-scale value surveys show that citizens tend to attach great value to a healthy environment and that they consider environmental degradation to be an important problem (Melis et al., 2014). Moreover, there appears to be a positive link between environmental concern and willingness to pay (WTP) for a clean environment (Pagiaslis & Krontalis, 2014).

In contemporary policy-making, taxation has three goals (Avi-Yonah, 2007). The first goal of taxation is to raise revenue to finance government functions, such as the provision of public goods. The second goal is redistribution, the transfer of part of the revenues to reduce inequality. The third goal of taxation is regulation of behaviour: citizens and business are incentivised or discouraged to behave in a certain way (Avi-Yonah, 2010). Environmental policy is probably the field in which regulatory taxation[68] has gained the most ground. Pigou (1920) highlighted the theoretical advantages of taxation as an instrument to address market failures and make private actors internalise external environmental costs. More recently, scholars have presented a (Pigouvian) carbon tax as a potentially efficient instrument for climate change mitigation (Pierce, 1991; Newell & Pizer, 2003; Avi-Yonah & Uhlmann, 2009).[69]

Notwithstanding the high efficiency, the use of regulatory taxation such as environmental taxes (ET) is not very widespread (Kallbekken et al., 2011; Oh & Svendsen, 2015). The alleged underuse is related to the low willingness to pay for the environment and the unpopularity of environmental taxation with the public. People are often opposed to the implementation of an ET, even when they support the objective behind it (Beuermann & Santarius, 2006; Kallbekken & Aasen, 2010).

In general, part of the unpopularity of the tax instrument is due to the fact that coercive policy instruments, such as a tax or a ban, are less appealing to people than positive instruments, such as a subsidy or suasion instruments (Hood, 1983). McCaffery and Baron (2003a) call this

[68] We use the term 'regulatory' in the broad sense, following the American school definition: "Regulation is any attempt by the government to control the behavior of citizens" (Meier, 1985). In the standard English school, the term is defined more narrowly as all prohibitions and obligations imposed by government (Vedung, 1998).

[69] Although in a second-best world with uncertainty, the efficiency of environmental taxes is subject to certain conditions, such as the slope of the marginal abatement curve and the marginal damage curve (Perman et al., 2003).

phenomenon 'penalty aversion'. Subsidies are a voluntary instrument, whereas taxation and command-and-control instruments "restrict people's freedom of choice and force people to change their own behavior" (Steg et al., 2006, p. 94). To Stern et al. (1993), this coerciveness aversion is a simple expression of the fact that people act out of self-interest. According to Attari et al. (2009, p. 1702), "hard regulations evoke psychological reactance, and individuals look for ways to re-establish their lost freedom".

However, the dislike of coercive policy instruments does not provide a conclusive explanation for the limited support for Pigouvian taxation. Taxation seems to arouse even more opposition than command-and-control instruments. Franzen and Meyer (2010) found that consumers' willingness to pay higher *prices* for the environment was significantly higher than their willingness to pay higher *taxes* for the environment, although those two options would have identical implications for them in practice. According to Clinch et al. (2006, p. 968), taxes have "particularly negative connotations". In the climate change related cap-or-tax debate, Avi-Yonah and Uhlmann (2009, p. 7) call an emissions trading scheme more politically feasible "simply because it is not labelled a tax". Nordhaus (2007) takes this conclusion even one step further, attaching the label "almost a four letter word" to a tax. Baron and Jurney (1993) and Kallbekken et al. (2011) found that people would sometimes vote against a tax reform even when it is to their benefit, a phenomenon which is referred to as *tax aversion*. Insights from behavioural economics (see section 2.2) provide some explanations for this - seemingly irrational – citizen attitude. In addition, two hypotheses from the literature may add to the understanding of tax aversion, which tends to be even greater in the context of the environment than in other fields (Green Fiscal Commission, 2009a). First, contrary to what studies find, people have a tendency to believe that Pigouvian taxation is not effective in changing behaviour to the benefit of the environment, or they at least underestimate its effects (Baranzini et al., 2014). Second, people do not believe that government will spend the revenues from the environmental tax in an optimal way. These and other hypotheses explaining low acceptance of environmental taxation are further detailed in section 2.3.

2.2 Other explanations for low acceptance of environmental taxation

The theory of using taxation to internalize externalities traces back to the work of Pigou (1920) and has been further elaborated by many other authors, such as Baumol and Oates (1988) and Coase (1960). The theory of Pigouvian taxation is based on the neoclassical theory of rational choice, which assumes that economic agents act in a rational way according to their individual preferences in such a way that their utility (or profit for companies) is maximized. However, the assumptions of the neoclassical model have since long been under attack by a variety of theoretical schools, including public choice theory, for having a 'romantic and illusory' notion of how governments function (Buchanan & Tollison, 1984). Instead, Buchanan and Tullock (1975) and other public choice scholars claim that rational politicians let themselves be influenced by the preferences of the actors who are subject to the policy, and that policy makers will be wary of implementing policies that go against the desire of the 'median voter' (Peters, 1991). This situation would engender suboptimal (instrument) choices which can be regarded as government failures (Caplan, 2001).

Public choice theory, in turn, has been criticized for making a caricature of individuals (Cullis & Jones, 1998). Disciplines such as economic psychology and behavioural economics explain the 'failures' of individuals by arguing that people, including policy makers, are facing bounded rationality (Simon, 1955). Policy makers do not *maximize* (benefits over costs) but aim to

satisfice, or aim for 'good enough'. They still seek rationality, but resort to unavoidable simplification to reduce complexity and keep matters manageable. More specifically, they use heuristics and are prone to biases when making decisions under uncertainty (Kahneman, 2003). Applied to environmental taxation, some of these biases contribute to explaining why support for environmental taxation and environmental tax reform is limited. The first of seven biases is *fiscal illusion* (Wagner, 1976): people's cognitive skills are limited, and even modestly complex tax systems or reforms cause them to make systematic optimization errors (McCaffery & Baron, 2003a; Chetty et al., 2009). For example, in case of an ETR, people clearly see and feel the environmental tax, but they do not (or much less) see or consider the benefits they get from the revenue recycling. For this reason, tax reforms with an environmental tax element and a labour tax element may just be too complex to grasp for most citizens. A second bias, related to the first, is the role of *salience*. People tend to dislike transparent taxes more than less visible ones[70], even when they have the same value (Chetty et al., 2009). Third, the *isolation effect* and the *aggregation effect* refer to people's failure to aggregate wins and losses in complex tax reforms and to look at the whole picture (McCaffery & Baron, 2003b, 2003a). A fourth bias is that people's perceived probabilities are distorted by desires, a phenomenon which McCaffery and Baron (2003a) refer to as *wishful thinking*. This may explain why people tend to believe subsidies are more effective than taxes to realise environmental goals, contrary to what studies find (Rienstra et al., 1999). A fifth relevant bias is the *endowment effect*, which refers to the fact that people tend to attach more value to the losses related to a tax reform than to the gains (Thaler, 1980; Daugbjerg & Svendsen, 2003). Hence, revenue-neutral reforms may not be sufficient to gain the public's approval for an environmental tax reform. The sixth bias is the so-called *metric effect*, which means that expressing an environmental tax in monetary terms (e.g. in euro) instead of a percentage change will reduce acceptability (McCaffery & Baron, 2003b; Hsu et al., 2008). The seventh phenomenon is the role of *framing*. In the context of an ETR, an example of positive framing or labelling would be to avoid the word 'tax' and replace it by 'contribution', 'fee' or just a description. Positive framing may entail increased support for an ETR (Kahneman & Tversky, 1984; Brannlund & Persson, 2012).

2.3 Empirical literature on support for ET and ETR

Several empirical studies have searched for determinants that help explain the support for environmental taxation. While a detailed systematic meta-analysis is beyond the scope of this paper, a multi-study comparison sheds light on the likely determinants of acceptance of ET. A summary of the empirical literature is presented in table 6. Each number refers to a study and the numbered reference list is added below the table.

[70] For example, a road toll tax with automatic payment by direct debit

Table 6. Determinants of support for ET and ETR: overview of empirical literature

factor	Effect on support for ET
Socioeconomic and demographic determinants	
Income	Pos in 24, 29, 44; neg in 27; inc in 3, 18, 38, 45, 47, 51
Age	Pos in 2, 44; neg in 24, 38, 51; inc in 3, 13, 29, 45
Gender (F)	Pos in 2; inc in 3, 29, 33, 38, 45, 51
Education	Pos in 3, 24, 29, 44, 51; neg in 27, 38 (both on transport)
Household size	Pos in 27; incl in 45
Unemployed	Neg in 51; inc in 3, 45
Car owner[a]	Neg in 3, 19, 29, 51; inc in 27, 38
Being a car commuter	Neg in 19, 29, 45
Frequent bicycle user	Pos in 19, 24, 45
Frequent public transport user	Pos in 45; neg in 19, 24
Living in city	Pos in 51
Health problem related to pollution	Pos in 24
Value-related determinants	
Trust in government	Pos in 3, 5, 19, 22, 25, 33, 51
Environmental concern	Pos in 2, 3, 8, 16, 18, 24, 25, 33, 41
Right-wing ideology	Neg in 2, 25, 38, 51; inc in 3
ETR = Infringement of freedom	Neg in 2, 16, 18, 30
Perceived domestic pollution	Pos in 38
Expecting efforts by others	Pos in 3
Perceived co-benefits of CO_2 reduction	Pos in 3
Determinants related to the design of the ETR/ other determinants	
Perceived effectiveness of the ETR	Pos in 4, 5, 8, 19, 28, 33, 35, 38, 41, 45, 47, 48, 50
Perceived fairness / ETR not regressive	Pos in 4, 5, 6, 10, 14, 16, 18, 23, 31, 33, 34, 35, 36, 46; neg in 14, 33
Perceived personal cost of the ETR	Pos in 3, 9, 25, 45, 47, 48
Specific trust that government can and will keep promise of earmarking	Pos in 4, 5, 9, 10, 12, 14, 19, 24, 27, 29, 36
Already have ETR	Neg in 5, 15
Perceived negative employment effects	Inc in 3
Level of understanding of the ETR	Pos in 5, 28
See ETR as complex	Neg in 5, 19
Labelling: not call it a 'tax'	Pos in 6, 26, 34
Specificity ET	Pos (for low tax rates) in 39; neg in 1, 41
RR: lump sum payments[b]	Pos in 34
RR: ETR[c]	Pos in 1, 3, 4, 5, 17, 27, 29, 32, 38, 40, 44, 45
RR: earmarking[d]	Pos in 1, 3, 4, 5, 6 11, 12, 17, 20, 21, 29, 32, 34,40, 44, 49
Trial period	Pos in 9, 52
Threshold type of tax[e]	Pos in 7, 9, 42, 43
Tax base is pollution and not resources	Pos in 37
Tax base refers to local pollution, not global	Pos in 37
Providing more information	Pos in 5, 32; neg in 19; inc in 34, 52

Pos, neg = positive, negative effect on support for ET, inc = inconclusive or no effect, RR = revenue recycling

Notes:

a. Road pricing and local congestion taxes, such as in London or Stockholm, are included in this literature overview, because they qualify as ET. However, the acceptance of such local tax systems tends to show some specificities, such as the stronger negative effect of owning a car, and the weaker positive effect of education.
b. Compared to an environmental tax with no mention of revenue recycling (for more explanation on revenue recycling options, see below in this section).
c. Compared to RR with lump sum payments
d. Compared to RR (= revenue recycling) with ETR

e. Compared to a regular ET. A threshold environmental tax is a tax with a zero tax rate up to a certain level of emissions or resource use. For example, an electricity tax with a zero tax rate for the first 3 MWh per household, and a positive tax rate above that threshold (Pezzey, 2006).

References: 1. Amdur et al. (2014) 2. Attari et al. (2009) 3. Baranzini and Carattini (2017) 4. Baranzini et al. (2014) 5. Beuermann and Santarius (2006) 6. Brannlund and Persson (2012) 7. Bristow et al. (2010) 8. Brouwer et al. (2008) 9. Cherry et al. (2014) 10. Clinch et al. (2006) 11. Convery et al. (2007) 12. Deroubaix and Lévèque (2006) 13. Dietz et al. (1998) 14. Dresner et al. (2006) 15. Ercolano et al. (2012) 16. Eriksson et al. (2008) 17. Felder and Schleiniger (2002) 18. Fujii et al. (2004) 19. Gaunt et al. (2007) 20. Globescan and PIPA (2007) 21. Green Fiscal Commission (2008) 22. Green Fiscal Commission (2009a) 23. Green Fiscal Commission (2009b) 24. Gupta (2016) 25. Hammar et al. (2008) 26. Hardisty et al. (2009) 27. Harrington et al. (2001) 28. Heres et al. (2013) 29. Hsu et al. (2008) 30. Jakobsson et al. (2000) 31. Joireman et al. (2001) 32. Kallbekken and Aasen (2010) 33. Kallbekken and Sælen (2011) 34. Kallbekken et al. (2011) 35. Kallbekken et al. (2013) 36. Klok et al. (2006) 37. Konisky et al. (2008) 38. Krupnick et al. (2001) 39. Lachapelle and Borick (2011) 40. Leiserowitz et al. (2016) 41. OECD (2006) 42. Pezzey (2006) 43. Pezzey and Jotzo (2013) 44. Rienstra et al. (1999) 45. Schade and Schlag (2003) 46. Schlag and Teubel (1997) 47. Schuitema et al. (2005) 48. Schuitema et al. (2010) 49. Shaw (2009) 50. Steg et al. (2006) 51. Thalmann (2004) 52. Winslott-Hiselius et al. (2009)

The study suggests the following conclusions. First, evidence that socioeconomic and demographic variables determine support for ET is inconclusive, with several studies finding contradictory results. Only education has a clear positive effect on support. Studies on the effect of income, age, gender, number of children and unemployment are inconclusive. Second, owning a car clearly influences one's acceptance of ET. Some studies even find a proportional drop in support per car owned (Thalmann, 2004; Baranzini & Carattini, 2017). Third, people who distrust government are less likely to accept ET. In addition to this general distrust, people often do not trust government to keep its promise to spend the revenues from an ETR on the environment. Fourth, people are sceptical about the potential of Pigouvian taxation to change people's behaviour in a more sustainable direction (effectiveness), and this arguably affects acceptability. Fifth, when an ETR is regressive in people's perception, they are less likely to be in favour of ET. Sixth, public support for ET, as for other environmental policy solutions, tends to differ according to the depth and specificity of the question in the reviewed studies' surveys. Expressed support for 'paying an environmental tax to solve environmental problems' is typically higher than for a specific tax such as higher fuel taxes. This may be explained by the fact that people do not think about concrete impacts or designs of environmental taxes before that concrete design is presented to them in a clear way with no room for misunderstanding (OECD, 2006). Another explanation maybe the role of salience (see section 2.2). A seventh conclusion is that empirical studies confirm the expected effect of framing or labelling (see section 2.2). Finally, empirical studies find evidence for some of the other theoretical claims (see sections 2.1 and 2.2), such as tax aversion, fiscal illusion, wishful thinking, salience, the metric effect, aggregation effect, framing and complexity.

The last set of important empirical results relate to the importance of recycling the revenues from an ETR. According to economic theory, adding the revenues to the general budget is the option that maximises welfare at the societal level (Ian W. H. Parry, 1995). Government will then use these resources where it feels societal needs are the greatest, or – in economists' terms – where the highest welfare gains can be achieved. However, adding the tax proceeds to the general budget makes for a very unpopular policy package. Opposition against environmental taxes is significantly lower when the tax proceeds are returned to the tax payers ('revenue recycling'). Various ways of realising revenue recycling are available. We created a 'Ladder of Acceptability of Revenue Recycling Options' (LARRO) by putting six recycling options in declining order of acceptance, based on the available empirical literature:

(1) financing specific environmental programmes (also called *earmarking* or *hypothecation*);
(2) reducing taxes on labour, consumption, corporate income, property or other distortionary taxes. Such an *environmental tax reform* (ETR) may reduce the distortionary impacts of the green taxes and even produce net employment creation (the so-called double dividend) or other welfare gains;
(3) returning the additional taxes from one sector to that same sector in a way that is not proportional to the emissions, pollution or resource use (*sector neutrality*);
(4) eliminating or mitigating regressive effects of the ET;
(5) lump-sum refund to the public;
(6) reducing public debt or adding to the general budget (which is strictly speaking not revenue recycling).

Several studies have revealed that the public does not prefer recycling the revenues by lowering taxes in other policy fields, such as labour, in a revenue-neutral way. Instead, the only recycling option that seems acceptable to most citizens, is the *earmarking* option: using the additional revenues for measures that clearly benefit the environment. These results point to the existence of a *trade-off* between efficiency and acceptability: the most efficient policy solutions get the lowest public support and vice versa (Rienstra et al., 1999; Felder & Schleiniger, 2002; Amdur et al., 2014).

Economists refer to this type of preference as non-rational. Several studies have dug deeper into the explanations for this phenomenon. First, people find it very hard to understand the link between ET and labour taxation; they do not see the logic behind it and therefore they reject it (Thalmann, 2004; Beuermann & Santarius, 2006). Second, from studies covering countries that had implemented ETRs, it appeared that people tend to be aware of the environmental tax side of the tax reform (*the cost*), but unaware of the fact that their labour taxes had gone down as well (*the benefit*) (Dresner et al., 2006). Third, even when they were explained that the government revenue would be fully recycled through lower labour taxes, many people in the study did not believe it and reckoned the reform would still, at the end of the day, fill government's pockets (Kallbekken et al., 2011; Cherry et al., 2014). The preference for earmarking is apparently related to the issue of trust (Anesi, 2006). Fourth, studies have reported that people's unease with the ETR lies in the confusing *terminology*. The term 'ecological tax reform' is problematic, as both 'ecological' and 'tax' are negatively connotated, and it contains no reference to labour (Dresner et al., 2006). Alternative framing and labelling could possibly increase support for an ETR (see section 2.2).

3 | Hypotheses and data

Based on the theoretical and empirical literature study, we propose three hypotheses, which we test using a large-scale survey.

Hypothesis 1. Acceptance of and willingness to pay (WTP) for environmental taxes (ET) is generally low, and lower for a specific tax (described in detail) than for environmental taxation in general (specificity hypothesis).

Hypothesis 2. Education and environmental concern are determinants of support for environmental taxes (ET), while age, gender, income, unemployment, household size, home ownership and being religious are not.

Hypothesis 3. Based on the literature, we rank the revenue recycling options as follows (in descending order of support):

a. Earmarking for the environment;
b. Lowering labour taxes (equal reduction of employer and employee social security contributions); this is the *ETR-option*;
c. Repayment to the economic sectors that face the highest risk of job losses owing to the ET;
d. Lump sum repayment to the public;
e. Lowering corporate income taxation (company profit tax)
f. Government debt reduction/general budget

We call this hierarchy the 'Ladder of Acceptability of Revenue Recycling Options (LARRO)'.

The empirical analysis in this paper is based on LEVO 2012, a survey conducted in Flanders, the northern part of Belgium. LEVO is the Dutch acronym for "LEvensomstandigheden in Vlaanderen Onderzocht" (research on living conditions in Flanders). It is an annual large-scale survey organised in the framework of a research seminar at the economics faculty of Ghent University. The fieldwork is carried out by master's students, while the organization, supervision, controlling and cleaning is performed by the authors. The main subject of the survey was living conditions and wellbeing but several questions were added on the topic of acceptance of ET. The survey used quota sampling and data was gathered from 1308 respondents. The data are statistically weighted to obtain a sample that is representative of the Flemish population in terms of employment situation, gender and age.

The data include socioeconomic and demographic characteristics such as age, gender, having a relationship, home ownership, health, number of children, income and being religious. For income, a distinction was made between objective income (in euro) and subjective income, which was a self-assessment scale ranging from 0 'completely disagree' to 10 'completely agree' for the position "My (household) income is sufficient to live well".

A question on the degree to which material expectations are met (a percentage between 0 and 100) offered an alternative wealth indicator. Finally, the survey contained questions related to a self-rating on twelve personality traits on a numeric 7-point scale: extrovert, altruistic, conscientious-dutiful, worried, hard to please, creative, optimistic, self-confident, emotional, progressive, jealous and having high expectations.

Finally, the questionnaire contained two questions related to environmental concern: "Do you think government is doing enough to tackle environmental problems?" and "Do you see climate change as a problem?". Both questions had five-point Likert response scales.

4 | Results and discussion

4.1 Support and WTP for environmental taxes

The questionnaire contained one question on the respondents' general acceptance of ET and one question on the acceptability of a specific carbon tax, levied on all energy products. The results are presented in table 7.

Table 7. Support for the general principle of ET and for a specific carbon tax (%)

	Strongly opposed	Rather opposed	Rather in favour	Strongly in favour
General environmental tax	14.5	36.1	42.3	7.1
Specific carbon tax	19.2	45.6	30.7	4.5

Nearly half of the respondents support the general idea of environmental taxation. Support declines to 35% when the tax is specified as a carbon tax that will raise energy prices. A Wilcoxon Rank test indicates that this difference is statistically significant (p=0.000). Consequently, our first research hypothesis, the specificity hypothesis, is confirmed. This result is important, because in reality the details of any announced environmental tax will be actively divulged by either the government or the opponents of the tax (Gaunt et al., 2007). Therefore, the survey result for the specific tax is a better predictor for real-life support than the general environmental tax result.

A third question directly gauged people's willingness to pay a carbon tax on energy, by asking which rise of the monthly energy bill people would find acceptable (table 8).

Table 8. Willingness to pay a carbon tax on energy (€/month rise of the energy bill)

	Max €0	Max €10	Max €20	Max €30	Max €40	Max €50	Total
%	30.2	44.0	16.7	5.0	0.9	3.2	100,0

The willingness to pay is low: 30% does not accept a higher energy bill, while 44% is willing to pay (only) €10. This result is in line with other studies and with the answers to the two support questions. It also confirms the existence of a trade-off between acceptability and efficiency, as we concluded in section 2.3. Note that in this stage, revenue recycling was not mentioned in the questionnaire.

To examine the link between support and willingness to pay, we construct a high support and a low support group for the two support questions. People who are 'rather in favour' or 'strongly in favour' of the tax are classed in the 'high support group' for that type of tax. Those who are 'rather opposed' or 'strongly opposed' to the tax end up in the 'low support group'. The four answering possibilities are combined in table 9. A large majority (73%) is consistently in favour of or opposed to both taxes. A Bonferonni post hoc test indicates that all pairwise comparisons of averages are significantly different (p=0,000) except for the two differentiated categories (low support for one and high for the other). Moving from low to differentiated, the WTP doubles, and then from differentiated to high support for both taxes, the WTP triples compared to the

low support group. This result provides support for the assumption made in the introduction that WTP can be regarded as an indirect measure of support for environmental taxation.

Table 9. Mean WTP in terms of acceptance of general and specific environmental taxes

	%	Mean WTP
Low support for both	43.9	6.52
Low support for general ET and high support for carbon tax	6.5	12.28
High support for general ET and low support for carbon tax	20.8	11.5
High support for both	28.8	18.00
Total		11.24

4.2 Determinants of WTP and support for ET

Table 10 shows which variables are important for understanding the inter-individual variation in the WTP. We perform an ordinary least square (OLS) regression using the maximum amount as dependent variable (e.g. for those indicating they want to pay maximum €10, the WTP variable equals €10). The selection of variables in the OLS model is based on bivariate significance tests. This means that several standard socioeconomic variables are not selected for the final model because they are not significant: age (and age square), gender, personality, education of the mother, having a relation, having children, being religious and being in good health. Objective income (in euro) and education are both significant, but since they are strongly correlated and education is more important than objective income, only education (years of schooling) is included in the model and objective income is not. Subjective income (self-assessment, income is sufficient to live well) is more significant than objective income and more independent from education, so it is selected for the model. Furthermore, the variable 'material expectations realized', as a proxy for 'wealth', is added to the model. Finally, we included some variables related to environmental concern. We create two dummies for the opinion whether government is doing enough for the environment: too little effort and too much effort; the reference category is 'adequate effort'. To capture the opinion of respondents on global warming, we add a dummy for those who consider it as a (big) problem; the reference category is 'minor problem or deny the issue'.

Table 10. Ordinary least squares (OLS) estimates for WTP an ET

	Unstandardized coefficients	Significance
(Constant)	-8.42	.000
Education (per year of schooling)	0.56	.000
Income sufficient to live well (subjective income)	0.84	.000
Material expectations realised	0.05	.006
Government_little effort	1.90	.006
Government_much effort	-4.09	.009
Global warming_problem	3.19	.000
Prob>F	0.000	
R Square	0.130	

All variables in the OLS regression model are significant, which means that they influence the WTP for ET. The table should be read as follows:

- each additional year of schooling increases WTP by €0.56;
- each point that subjective income is rated higher (on a 1 to 10 scale) increases WTP by €0.84;
- each percentage point that material expectations are more met increases WTP by €0.56;
- the WTP of respondents who think that government is not doing enough to protect the environment is €1.90 higher compared to those who think government is doing enough;
- the WTP of respondents who think that government is doing too much to protect the environment is €4.09 lower compared to those who think government is doing enough;
- the WTP of respondents who consider global warming as a (big) problem is €3.19 higher compared to those who think it is a minor problem or who deny the issue.

The conclusion from the standardised coefficients analysis is that education is the most important determinant of WTP.

Further testing using an ordinal logit model with the same variables provides similar results.[71] Our analysis provides evidence to confirm our second hypothesis: education, income and environmental concern are determinants of support or WTP for ET, whereas most other socio-demographic variables are not. These results are in line with the findings of other studies, although many other studies were inconclusive on the effect of income. In this study, we found a small positive effect of income expressed in monetary terms and a stronger effect of the subjective parameter of having an income that is 'sufficient to live well'.

4.3 Support for Environmental Tax Reform (ETR)

Environmental taxes are aimed at inducing behavioural responses benefiting the environment. However, they also generate revenue, which could be 'recycled' to 'compensate' for the taxes. Seven such revenue recycling options were presented to the participants of the survey.

Table 11 shows that the highest support goes to the two earmarking options, in which the revenues of the environmental taxes are spent on environmental policies. The option of 'investments in renewable energy' receives the highest support, closely followed by the option 'actions to improve the climate or the environment'. The ETR receives lower support but remains a popular recycling option in the eyes of the survey participants. The relatively small difference in acceptability between earmarking and ETR is also found by Thalmann (2004) but Baranzini and Carattini (2017) find a larger difference. Behind these three preferred options, acceptability drops sharply for public debt reduction, lump sum repayments and specific sector refunds. Finally, reducing corporate taxation is the least preferred option by far for the participants.

To test whether the average support for the alternatives differs significantly, a pairwise comparison is performed. The p-values of the Wilcoxon rank test are provided in the last column of table 11, each time compared to the alternative in the line above.

[71] These results can be obtained from the authors on request

Table 11. Public support for different compensating mechanisms (%)

	Strongly opposed	Rather opposed	Rather in favour	Strongly in favour	p-value Wilcoxon test
Investment in renewable energy (earmarking)	4.4	14.0	47.7	33.9	
Actions to improve the climate or the environment (earmarking)	3.3	15.0	54.8	26.9	0.005
Reducing labour taxes such that both employers and employees get half of the advantages (ETR)	7.1	19.7	42.5	30.6	0.011
Reducing public debt	17.0	29.9	36.0	17.1	0.000
Refund with an equal share to all people living in Flanders	20.5	27.2	35.9	16.4	0.209
Refund to those economic sectors that are suffering from the carbon tax to prevent loss of jobs or delocalization	15.0	35.6	39.4	10.0	0.363
Reducing corporate taxes	23.8	39.2	25.2	11.8	0.000

The results largely support our third hypothesis regarding the 'Ladder of Acceptability of Revenue Recycling Options (LARRO)'. Only the option of reducing public debt is ranked higher than in most other empirical studies. A speculative explanation for this difference may lie in the fact that Belgium is a 'debt-burdened' country, with public debt exceeding 106% of GDP in 2016.[72] Another hypothesis is that our phrasing of this option as 'debt reduction', may be more acceptable to the public than the option 'adding to the general budget'. Future research could provide a clearer answer to this question.

5 | Conclusion

In this paper, we examined the determinants and the conditions of public support for environmental taxation and environmental tax reform. Most of the empirical insights are immediately policy relevant and can instantly be translated into policy recommendations. Therefore, the main conclusions of this paper are presented as a recommended policy package.

This paper has shown that ET and ETR are delicate operations from the perspective of public acceptance. However, the trade-off between acceptability (earmarking) and efficiency (ETR) can significantly be abated by designing an ETR with the following six characteristics. First (and foremost), the majority of the tax revenues should be spent on improving the environment. Second, significant time and budget should be spent on communicating the ETR, with a focus on highlighting the benefits to the public of both the ET side (environmental improvement; highlighting the costs of inaction) and the revenue spending side (the ETR). Specific attention should be given to preparatory (independent) studies providing evidence for the environmental

[72] Figures from http://www.debtagency.be/nl/cijfers/nlensemble-des-pouvoirs-publics/datagovernment debtdebtratio , accessed March 17, 2017.

effectiveness of the environmental tax. This study should be communicated in a way that it reaches a large public, using language that is understandable to all. Third, providing specificity on the ET is unavoidable. Trust in the government's good intentions with the tax reform may be enhanced by providing full transparency and coherence, both in the design and throughout the policy process of ETR. Moreover, specificity and salience on the revenue spending side should be a target. For example, a reduction of labour taxes could be mentioned explicitly on monthly salary slips and the annual tax assessment for reasons of salience. Tax increases are to be communicated in percentages, and tax reductions in absolute currency. Fourth, to overcome the endowment effect, the whole operation could be made 'more than revenue-neutral', i.e. creating a net cost for government. Fifth, spending part of the revenues to mitigate the regressive impact of the ETR will increase acceptability. Sixth, the possibility of a trial period and a 'threshold Pigouvian tax' instead of a regular tax should be studied and considered. At the same time, these additions should not increase complexity too much: the more complex the ETR, the less likely it will be supported by the public.

In this study, several hypotheses were tested and variables were identified that may determine or explain support for a green tax reform. However, the study has also demonstrated that public acceptability and ETR are complex phenomena, and despite the multitude of existing studies, many potential determinants and design improvements have not (yet) been uncovered or fully understood yet. There is a need for a better understanding of the acceptability conditions of ETR. An experimental study on the effectiveness of measures or design choices that tackle the efficiency-acceptability trade-off could aim at transforming an 'efficient but unacceptable' ETR into an 'efficient and acceptable' one. Furthermore, future empirical studies could shed a light on the role of co-benefits of a carbon tax, on ways to convince the public of the effectiveness of environmental taxation, and on the potential of innovative policy mixes, including threshold taxation, trial periods and bonus-malus systems. Finally, knowledge on the Ladder of Acceptability of Revenue Recycling Options (LARRO) could be expanded by adding smart policy mixes to the recycling options.

6 | References

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Conclusions

1 | Introduction

This concluding chapter provides an overview of the main conclusions of this PhD study. Two groups of conclusions are distinguished. The first group concerns transversal conclusions that are based on multiple parts of the PhD study and on the literature. They offer in-depth reflections on the use of environmental taxation in policy mixes, the observed trade-offs between the efficiency of an ETR on the one hand, and its acceptability and regressivity on the other hand, the importance of instrument design and the role of the government as a leader or follower of new societal trends and challenges. The second group of conclusions are directly aimed at answering the eight 'level 3' research questions that were formulated at the outset of the research project.

Further sections of this chapter discuss the contributions and limitations of the PhD research. The chapter ends by presenting two types of recommendations. The first group of recommendations is aimed at future research, whereas the second group contains recommendations for policy makers.

2 | Transversal conclusions

2.1 The do's and the don'ts of policy mixes

One of the transversal lessons of this PhD study is that environmental taxation alone will not offer the solutions to all complex environmental problems. As environmental problems are increasingly complex in nature (Bennear & Stavins, 2007; Rogge & Reichardt, 2016), solving them will require long-lasting and complex policy interventions, involving multiple instruments, strategies, target actors and policy processes. Among these integrated strategies, effective and

efficient policy mixes constitute the most central challenge, comprising a combination of instruments and policy processes.

Policy mixes can be designed for different reasons:

- As an answer to the complexity of the societal problem, for example climate change mitigation;
- When multiple externalities or policy goals exist, for example reducing carbon emissions and unemployment at the same time;
- To increase acceptability, for example an ETR with an environmental subsidy as a revenue-recycling measure;
- To compensate stakeholders for any losses caused by the main policy instrument, for example an ETR with repayment to the sectors that pay the tax;
- To reduce negative side effects of the main policy instrument, for example an ETR that includes measures to reduce regressivity or competitiveness losses;
- To reduce economic distortions that may be caused by the main policy instrument, for example an ETR with increased environmental taxation and reduced labour taxation.

The policy mix that is mentioned most often in this PhD study is an environmental tax reform (ETR), but various other combinations with an environmental tax are possible. An interesting option that is rarely referred to in the literature is the *environmental subsidy reform* (ESR), which is the mirror image of an ETR. Firms get a subsidy for environmental improvement, but at the same time they are required to make lump-sum repayments to the government, which aims at revenue-neutrality (Perman et al., 2003, p. 236). Because of the compulsory repayments, this policy mix is a de facto bonus-malus scheme (see table 1 of the introductory chapter), with the most environmentally-friendly firms ending up with a net subsidy, and other firms ending up as net tax payers. ESR is an interesting theoretical policy mix, but we did not find any applications in practice. Presumably, ESR is not popular as the budgetary impact for both the government and the target group may be hard to predict. Moreover, ESR may face serious acceptability problems, as because of the endowment effect (see paper 4), the net payers may feel robbed more than the net receivers feel blessed.

In most cases, policy mixes consist of independently operating instruments, for example a carbon tax and innovation subsidies for companies. In some cases, however, the instruments are integrated into one 'hybrid' instrument. A good example is an ETS with a price floor, which is currently implemented in the UK. Some policy mixes come about by *policy packaging*, which means that first any previously existing policies are removed at the outset and a new custom-made policy mix is designed. But in most cases, removing existing policies is not easy, and new policies are often built upon existing policy tools. This process is called *layering* or *policy patching* (Howlett & Rayner, 2013).

It is important to note that policy mixes are not a panacea for solving the problem of complexity in environmental taxation. On the contrary, poorly designed policy mixes run the risk of ending in policy failure or at least in poor efficiency. The three main conditions for a 'smart' policy mix (consistent instruments, coherent goals and congruency with policy style) have been discussed in section 3.2.5 of the introductory chapter. Furthermore, several risks and challenges should be considered before implementing a policy mix. First, unthoughtful layering of instruments poses the risk of overdesign: too many instruments are combined, which leads to an inconsistent policy portfolio (Howlett & Rio, 2015). Each instrument should have its own added value, and should not be decided just to please multiple stakeholders. Before implementing new ETs, it is more

efficient to first remove any environmentally harmful subsidies that may still be in place as these instruments counteract each other. Second, in some situations, combining certain instruments to cope with a single environmental problem should be avoided (Gunningham & Sinclair, 1999). A first example is the combination of an ETS and a carbon tax in the context of climate change mitigation. The effect of the tax erodes the effect of the ETS, leading to efficiency loss (Dias Soares, 2007). In a similar vein, implementing a tradable white certificate scheme to reduce emissions where an ETS is already implemented with the same goal, will not lead to additional emission reductions because the amount of allowances on the market does not change (Sorrell et al., 2009). Third, policy makers need to acknowledge that complex policy mixes require advanced policy coordination between different departments and government levels. For example, reforming Belgian company car subsidies for the benefit of the environment would require collaboration of at least eight policy actors:

- Federal finance minister for the fiscal treatment;
- Federal labour minister for salary regulations;
- Three regional environmental ministers for the environmental aspects;
- Three regional transport ministers for the mobility aspects.

Additionally, for such governance reforms, several non-state actors should be consulted, including employers' and employees' organizations, sector federations, environmental movements, and drivers' associations. In sum, this governance arrangement is immensely complex which increases the risk of policy layering and uncarefully designed policy mixes as a way of compromise. Moreover, empirical studies have emphasized that political cross-departmental and multilevel government cooperation has so far been limited, ad hoc-based and not focused on the most central and politically-sensitive policy issues (Bachus & Spillemaeckers, 2010).

As a conclusion, in the context of complex environmental policy-making, policy mixes are an indispensable element in the toolbox of the government. However, policy mixes should be designed in a smart (=well-designed) way, which goes for each target, instrument and design element. If policy mixes are used as an easy solution or compromise for divergent political positions, they may end up being even less efficient than the 'old-fashioned' single instruments.

2.2 The big trade-offs

In **paper 4** of this PhD study, I demonstrated the existence of a trade-off between efficiency and acceptability of an ETR. Using all the revenues from the ETR for environmental subsidies and investments will significantly improve its public acceptance (and its environmental effectiveness), but at the same time impair its efficiency.

While this is an important conclusion, I feel it can be extended to more elements than just acceptability. After conducting this PhD study, I see three additional elements to the trade-off. First, a second trade-off exists between the efficiency and the *equity* of an ETR. We limit the notion of equity to the absence of regressive elements of the ETR. The most efficient ETR is the one that recycles the revenues to a reduction of the employers' labour taxes or social security contributions. However, this adversely affects the situation of financially vulnerable households. Conversely, an ETR that hypothecates a significant part of the revenues to low-income families can be poverty-neutral or even progressive, but the lump-sum repayments to this target group inevitably affect the ETR's efficiency. Second, a similar trade-off can be observed between efficiency and *competitiveness*: a lump-sum (or output-based) repayment to the sectors that

need to pay the environmental tax may minimize negative effects on competitiveness, but it will come at the cost of lower efficiency. Third, expanding our analysis to multiple evaluation and instrument choice criteria, I propose to introduce the notion of *time* into the trade-off discussion. It appears that the three trade-offs discussed in this section are at their highest in the short run, but gradually diminish over time. Some may even completely phase-out in the long run. I discuss this conclusion for the three trade-offs.

First, for the acceptability trade-off, the fact that ET and ETR's environmental effects are limited in the short run but strong in the long run (see **paper 3**) is a problem for the politics of ETR. Generally, people think about the future in terms of no more than ten years, and they find it hard to imagine effects or outlooks that go beyond that limit (Tonn et al., 2006). In most cases, they will simply ignore time changes in their assessment (Kunreuther et al., 1998). Thus, people find it hard to feel appreciation for a benefit (environmental improvement) that is – from their perspective - in the distant future. Likewise, political decision-making predominantly takes on a short-term perspective (Meadowcroft, 2009), as politicians' rationality is equally bound by the temporal bias just as any other people's. Moreover, politicians' short-term bias or myopia is intensified by the political cycle of elections, which creates an additional incentive to focus on the short term (Bonfiglioli & Gancia, 2013). Sterner (2007, p. 3201) summarizes this problem as follows:

"*In the short run, there is little environmental effect but a big resistance that makes politicians hesitate. The important environmental effects come in the long-run but that is a limited consolation to politicians trying to get re-elected and therefore looking for visible progress in the short run*."

Second, the regressivity trade-off is equally higher in the short run than in the long run. In the short run, many low-income families' options to reduce their energy consumption after the introduction of an ETR will be limited. In the long run, the awareness of the higher cost will lead to some energy-saving behaviour, but a more important long run improvement can be expected from technology: the higher environment tax will improve environmental efficiency performance of new heating devices and the insulation of housing. However, the transition to a low-carbon society for low-income households faces more obstacles than for the average citizens. Consequently, repayments to this vulnerable group, particularly in the short run, are required, next to a policy mix to accelerate the transition for this societal group. This policy mix may contain, next to an ETR with targeted repayments, instruments such as minimal energy performance standards for rental housing and energy saving education for low-income families. Instruments that hollow-out the environmental effects of the ETR, such as rebates or exemptions for the ET part of the ETR, should be avoided in this policy process.

Third, the competitiveness trade-off is often associated with reduced economic growth (S. Smith, 2003). In the short run, GDP loss on the meso and macro level is indeed possible in certain scenarios (Bassilière et al., 2009). After a couple of years, GDP loss declines or is even transformed in additional growth (Bossier & Vanhorebeek, 2003). The reason is that in the long run, the tax offers an incentive for improved technological development (see **paper 3**), which may lead to economic growth. In sum, compensating measures to sectors that pay the environmental tax can help to tackle short-term competitiveness losses. However, such support measures should be temporary and should be avoided in the cases where no sectoral losses occur as a result of an ETR.

2.3 Acceptability of sustainability transitions

Paper 3 of this dissertation demonstrated that the policy makers face important limitations in their capacities to direct societal changes, including socio-technical transitions, in a desired (sustainable) direction. Government's traditional top-down policy-making role, using decision-making mechanisms and choosing policy instruments, seems insufficient to solve complex contemporary societal issues such as climate change. In addition, single instrument approaches, including the instrument of environmental taxation, face political and other challenges which prevents optimal instrument and design choices.

While paper 3 demonstrates the challenges, **paper 4** of this PhD offers several potential solutions coming from the field of behavioural economics. The first observation that can be made by combining the insights of paper 3 and paper 4 is related to the *framing* of a sustainability transition. Although 'radical change', 'dominant regime' actors and 'destabilization of incumbent regimes' may be accurate terms to describe the normative elements of a socio-technical transition, they may not be the optimal labels to trigger a policy debate on the short term. While one of the policy recommendations in paper 4 was 'do not call it a tax', in this sense a new recommendation could be 'do not call it a sustainability transition', as the rather negative wording may deter both the large public and the policy maker. For example: 'the implementation of a policy mix to accelerate the realization of a low-carbon economy' may be a less threatening label than 'a removal of all fossil-fuel subsidies to phase-out coal', while in practice the policy actions may be similar. An example of a policy label that has gained a lot of traction in and around policy subsystems is 'circular economy'. While the traditional issues of 'incinerating versus landfilling' are still discussed under the new label, the much more positive term than the more traditional 'waste management' adds a positive association that is more capable of uniting radical environmental NGOs and conservative regime business actors behind the flag.

2.4 The importance of instrument design and context conditions

The design of an environmental tax is at least as important as the choice of the instrument. In this section, we give an overview of the most important design elements for an ET, divided into four groups: design elements related to the tax level, the tax base, the revenue recycling and other design elements.

Design conclusions related to the tax level

- The optimal tax rate is inversely proportional to the price elasticity of the tax base (Ramsey, 1927). In other words: in case of an inelastic demand, the tax rate can/should be higher.
- The optimal environmental tax rate in a first-best world equals the marginal damage cost (or the marginal external cost) of the pollution (Perman et al., 2003). In a second-best world, under imperfect competition, the tax should be lower than the marginal damage cost (Ebert & von dem Hagen, 1998).
- A downside of a regulatory tax is that it is hard to determine the optimal tax rate from the outset. There is a risk of suboptimal efficiency when a tax rate is too low or too restrictive (Hepburn, 2006). In theory, the policy maker can follow a trial-and-error strategy, adjusting the tax rate one or multiple times, but politically this is difficult to push through. On the other hand, gradually increasing the tax rate in a pre-announced way will increase its efficiency, as the target groups have more time to adjust and anticipate (**paper 1**).

Design conclusions related to the tax base

- The tax base should represent the objective of the policy intervention. For example, if a government wants to reduce NOx emissions of cars, an increase of both petrol and diesel excise taxes is not recommended, as a diesel car's NO_X exhaust is up to fifteen times higher than a petrol-powered car (Verbeek et al., 2014).
- The tax should be linked to the emission as closely as possible. This means that if the objective is to reduce CO_2 emissions, the tax should be the emission itself (Oates, 1995; Edenhofer et al., 2010). For example, raising car registration taxes will be a less efficient solution for diesel car CO_2 emissions than a general CO_2 tax. In practice, however, this general rule cannot always be followed because of problems related to measuring or enforcement, and proxies to the emissions are used (see introductory chapter, 3.3.2).

Design conclusions related to ETR and revenue recycling

- Part of the revenues from the ET should be dedicated to environmental purposes (earmarking) for reasons of public acceptability;
- Conversely, the larger the part of the revenues that are used to cut back on distortionary taxation, the more efficient the ETR will be. This design condition can never fully be reconciled with the previous one. The only solution to this acceptability-efficiency trade-off is a compromise, which is a typical feature of a policy mix.
- Any ETR should be part of a broader policy mix, which includes a large communication campaign to explain to the public how it works, and convince people of its effectiveness and fairness.

Other design conclusions

- In case of a policy mix, the design of the tax should take into account consistency with the other instruments.
- Exemptions to environmental taxation impair its effectiveness. It is therefore advisable to limit the exemptions and reduced rates as much as possible, and to tackle any side effects by compensating measures outside instead of inside the chosen environmental tax design.

Next to the design, it is important to know the context conditions pertaining to the target group or sector, the cost curves and the policy environment. First, if the policy maker has limited information on the individual firms' cost curves, a tax is a better instrument choice than an ETS (Perman et al., 2003). Second, in some cases where markets are absent and problems such as asymmetric information, moral hazard or other market failures are present, a tax may not be the best instrument choice (Perman et al., 2003). Third, when the marginal abatement cost curve is steeper than the slope of the marginal damage curve, taxes remain a strong instrument. However, when the marginal abatement cost curve is less steep than the marginal damage curve, other instruments such as command-and-control instruments may be more efficient than taxes (Baumol & Oates, 1988; Perman et al., 2003).

2.5 Policy: leading or following public opinion?

Do policy makers steer society in a certain direction by making policy, or do policy makers follow society by regulating new trends initiated by other actors? This question has been touched upon explicitly or implicitly on different occasions in this PhD study. It links to the policy-making models that were presented in the introductory chapter, where the rational model would support the second thesis, and the other models would take different positions in the spectre between the two opposing theses. This question equally links to the research question of

paper 3: the conclusion on the potential of government intervention in general or ET in specific to influence sustainability transitions will depend on the position one takes regarding the 'role of the government' question. The same can be said about **paper 4**: the perspective of a following government instead of a leading one would strongly increase the importance of public acceptability.

As is the case with this sort of questions, in my view the truth lies somewhere between the two opposite positions. I agree with Geels (2012), who claims that "*Policy makers have no privileged position outside the system (a 'cockpit') from which they can pull levers and change the transport system. Instead, they are part of the system and are constrained by their dependence on other actors.*" According to Docherty and Shaw (2011), this dependence may have become stronger with macro-trends such as liberalization, privatization, deregulation, and devolution. Policy makers are dependent on industries for jobs, taxes, economic growth, and new technologies (Luger, 2000), and this makes them more receptive to industry wishes and lobbying, even when the public good is at stake. In a similar vein, policy makers need to consider the – often contradictory - expectations of many different actors, such as citizens (and voters), companies, sectors, NGOs, other government levels, administrations and agencies. On the other hand, I do not believe in a toothless and docile government as it is sometimes portrayed by sustainability transitions scholars. Past environmental successes have proven that government is sometimes capable of pushing through policies with or without the consent of all societal stakeholders. Examples include the ozone layer multilateral treaty on the international level and the sharp drop in dioxin emissions in Flanders. In sum, environmental taxes and other policy instruments can still play an important role in bringing about environmental change and encouraging a sustainability transition.

3 | Answering the research questions

The eight level 3 research questions have been answered throughout this PhD study. In this section, a summarizing overview of all the answers is presented.

[Q1] How can the (non-)use of ET be explained, departing from instrument choice theory?

The origins of Pigouvian taxation can be positioned in the rational policy-making model. This model departs from rather unrealistic assumptions, which can also be said about the first-world theoretical model behind environmental regulatory taxation. However, even when the rational model is rejected for the more realistic mixed-scanning model, the policy maker whose rationality is bounded, can have sufficient information and skills to opt for a tax to solve an environmental problem. The actual instrument choice by the policy maker is based on both rational and political criteria, and policy subsystems can be identified as multi-stakeholder spaces where rational and political considerations lead to policy decisions in a dynamic process of discussion and bargaining.

[Q2] How does ET compare to other policy instruments?

ET can be positioned in the five-element taxonomy framework that is presented in the introductory chapter. First, ET is an *economic* instrument, based on the underlying mechanism of 'exchange'. The target group has the choice to continue to pollute and pay the tax, or to abate

and exchange that effort with reduced tax payments. Second, ET is clearly a *negative* instrument, as the polluter who does not change his or her behaviour is 'punished' by having to pay the tax. However, when the ET is expanded to a revenue-neutral ETR (policy mix), positive and negative instruments are combined and some taxpayers will even end up paying less than in the situation before the ETR. Third, on the continuous scale of *coercion* from voluntary to compulsory, the tax is at the 'compulsory' side, indicating a high degree of coercion or intrusiveness. Again, by implement an ETR instead of a single ET, government can add multiple non-coercive instrument to the policy package, such as environmental subsidies, awareness campaigns, lump-sum compensations to poor families or repayments to economic sectors. Fourth, ET is a *general* measure, since the tax usually applies to a large target group and not to individual companies or citizens, although in specific cases the number of taxpayers can sometimes be limited. For example, if the Flemish government would introduce a tax on the extraction of quartz sand, the target group would be limited to just one company, Sibelco, as this is the only company extracting quartz sand in Belgium (Bachus & Van Eynde, 2013). Fifth, and finally, both an ET and an ETR are *substantive* instruments, which means that they are indirect regulatory policy instruments aimed at influencing the behaviour of certain societal actors.

[Q3] How can the (under)use of ET in practice be explained?

The fact that ET is an effective and efficient instrument in many situations can explain why this instrument is regularly used by many governments worldwide. However, other instruments, such as command-and-control instruments remain more popular, and the relatively recent breakthrough of climate change mitigation on most countries' policy agendas has entailed a boom in the use of emissions trading schemes (ETS) but not of carbon taxation. In this PhD study, two explanations for the limited use of ET have surfaced. First, companies and economic sectors dislike (and will lobby against) negative instruments, as they raise their costs. If they cannot avoid them, they prefer grandfathered and even auctioned emissions trading to carbon and environmental taxation. Second, the public equally reject constraining policy instruments in general, and especially environmental taxes. An ETR with environmental earmarking is more acceptable to the public than a single tax, but a certain degree of reluctance towards any design involving an environmental tax will remain.

[Q4] How can different types of indicators for measuring the greening of a tax system be evaluated?

Revenue-based indicators are the most frequently-used type of indicators for measuring the greening of a tax system. They have the advantage of being readily available and comparable over time and between countries. However, they also have important downsides, with the most important being the validity problem: increased pollution or energy use can give a boost to rising revenues, which can lead to a 'false-positive' conclusion of greening. Aggregated tax rate-based indicators provide information that is complementary to the revenue-based indicators, as they are not linked to quantities. However, weighting choices to be made will always be somewhat arbitrary, which can equally affect validity. Individual tax rate-based indicators again provide complementary information, but only on a limited number of taxes and not on the whole tax system.

[Q5] Which alternative aggregate indicator(s) can be developed to improve the existing set of indicators?

Three new types of indicators are developed in this PhD study, none of which have been offered in the literature as alternatives to revenue-based indicators before. Especially the concept of

aggregate tax rate-based indicators is one of the innovative contributions of this PhD study. In paper 2, Laspeyres and Lowe types of index numbers are developed, next to individual tax rates and the OECD-developed implicit tax rate on energy as alternatives to revenue-based indicators. The three new types of indicators offer complementary insights on the greening of a tax system rather than making revenue-based indicators obsolete. This conclusion leads to the logical recommendation to use all four types of indicators together to come to a comprehensive conclusion on the greening of a tax system.

[Q6] Given its policy context and comparing with the EU, is a carbon tax or an emissions trading scheme the optimal climate mitigation policy instrument for the case of China?

Four perspectives are discussed to answer this question. First, from the perspective of administrative efficiency, a carbon tax is much easier to implement than a cap-and-trade system. Second, politically, China is no different from most other countries and political systems, in that a tax is the least popular policy instrument to regulate behaviour. Third, the distributional impact of a carbon tax may be more negative than an ETS, but this difference can fully be eliminated by recycling the revenues of an ETR with sufficient emphasis on avoiding a regressive impact. Fourth, the competitiveness impact of a tax and an ETS with full auctioning is expected to be similar. As a final observation, China's choice to opt for an ETS with most allowances granted for free paves the way for the three trade-offs described in section 2.2 of this chapter. This choice affects effectiveness and efficiency, but improves political acceptability and alleviates regressivity and competitiveness concerns.

[Q7] What is the potential of environmental taxation as a policy instrument for fostering sustainability transitions?

The conclusion of paper 3 is that, although transitions are complex and the impact of government policy is often unpredictable, well-designed environmental taxes can contribute to a certain change in a desired direction. The highest impact of regulatory taxation lies in long-term *technological change* and on influencing *social practices* and their underlying materials. In both cases, it is important to evaluate an environmental tax on its long-term effects, because elasticities tend to be larger in the long run than in the short run. In order for a tax to survive multiple government terms, it is advisable to take into account the recommendations of paper 4 to increase political acceptability. The use of policy packages, environmental earmarking, communication instruments, and insights from behavioural economics will increase the chances of a well-designed ETR to survive more than one political term.

[Q8] What are the factors determining public support for environmental tax reform and how can this support be increased?

Two groups of determinants of public support for ET and ETR were derived from the literature and from our own survey analysis. The first group of determinants relates to the socio-demographic and value-related background of citizens. They include education, ownership of a car and trust in government. The second group of determinants is related to the design of the tax or the tax reform. The fact that the largest number of determinants is in this group shows that it is possible for policy makers to improve the acceptability of an ETR. First, a significant part of the revenues should be hypothecated to the environment. Second, a large and transparent communication campaign is needed to convince the public of the environmental effectiveness of the policy mix and to raise people's trust in government. Third, part of the revenues should be used for compensating financially vulnerable households. Fourth, insights from behavioural

economics should be integrated in the policy design, including salience and the endowment effect. And fifth, excessive complexity should be avoided as this will impair public support.

4 | Contribution to the literature

This PhD study has contributed to the literature on theory, methodology and empirics. I see six theoretical contributions, one methodological and one empirical contribution.

This PhD study combines various theoretical frameworks from political science and economics. On that account, the main original contribution of this study to theoretical literature does not lie in the in-depth treatment of one of those theoretical schools, but rather in the combination of different theoretical bodies, some of which have not been combined before.

The first original contribution to theory is the mere theorization of the operationalization and the measurement of the greening of tax systems. This analysis is on the theoretical level of 'operationalization', which, as I argued in section 3.1 of the introductory chapter, I see as a sixth level of theory on top of the five levels developed by Blaikie (2005). Before the publication of **paper 2**, the most frequently used indicators, based on tax revenues, were used and reproduced by both academics and policymakers, without any question on their underlying validity problem. A related second contribution is the combination of the theory behind indicator development for the greening of a tax system on the one hand, and index theory on the other hand (**paper 2**). This combination enabled the development of the new (tax rate-based) indicators, which are more valid for the measurement of the greening of tax system than revenue-based indicators.

The third contribution of this PhD is the combination of the theory of environmental taxation and the theory of sustainability transitions (**paper 3**), aimed at explaining and predicting the impact of ET on sustainability transitions. Transition science has permeated economics literature much less than it has social science literature (van den Bergh & Kemp, 2006). As a result, there has not been much confrontation between those two theoretical schools, although both have their view on the role of government and policy instruments to reach long-term environmental goals. The combination of the two theoretical strands led to predictions of the potential of ET in policy mixes aimed at long-term sustainability transitions. These insights can be regarded as new hypotheses, which can be empirically tested in future research.

The fourth contribution combines the literature on public support for policy instruments with the literature on environmental taxation (**paper 4**). I provided explanations for public support and willingness to pay by exploring possible relevant insights from instrument theory, economic theory and behavioural economics. Moreover, these theories are translated into three hypotheses, which are empirically tested, based on a large-scale survey. This exercise is level-five theory use in Blaikie's (2005) model (theoretical or explanatory systems).

A fifth contribution lies in the combination of theoretical policy-making models and instrument theory with the economic policy instruments of carbon taxation and emission trading schemes (**paper 1**). This analysis contributed to explaining and predicting the impact of a choice for a carbon tax vs. an ETS, for the case of China, which can also be fit in Blaikie's fifth level of theory use.

A sixth and final contribution is the fact that this PhD study links the literature on policy mixes with the literature strands of sustainability transitions and public support for policy instruments (**Introduction and papers 3 and 4)**. This combination contributes to explaining the (non-)use of ET as an environmental policy instrument. For example, our empirical results on the 'Ladder of Acceptability of Revenue Recycling Options (LARRO) offer significant refining on the existing knowledge on the determinants of support for ETR.

On the methodological side, although some experts involved in the use of indicators for measuring the greening of a tax system were aware that the dominantly used indicators suffer from severe flaws, no efforts had been undertaken to improve the methodology. This PhD is the first effort to present alternatives for the dominant revenue-based indicators. Additionally, the choice to use index theory to improve the methodology for measuring the greening of a tax system was an original idea, first developed in this PhD study. The use of index theory enabled us to develop new types of aggregate tax rate-based indicators for the greening of the tax system, with higher validity than existing indicators. This contribution builds further on the theoretical first and second contributions listed above. In my view, the development of the indicators is a methodological contribution, while the use of index theory pertains to theory use. This analysis illustrates that methodological development can have a solid base in theory.

Finally, what was also missing in the literature on environmental taxation was convincing *empirical* evidence on the determinants of support for environmental taxes from the public. The survey that was presented in this study (**paper 4**) adds to the knowledge on that behalf. We found empirical support for all three hypotheses: (1) support for ET is lower if taxes are specified in detail; (2) education, income and environmental concern are determinants for higher support for ET; and (3) our proposed 'Ladder of Acceptability of Revenue Recycling Options (LARRO)' offers a reliable ranking of revenue recycling options based on the preference on the public.

5 | Research limitations

I see the combination of multiple theoretical bodies as one of the main original contributions of this PhD study. However, the downside of discussing a relatively large number of theoretical strands, is that their analysis is less profound than in most single-discipline PhD dissertations. The consequence is that readers who read this thesis with the perspective of one single discipline or theoretical strand, might feel unsatisfied with the depth of the theoretical analysis. However, I invite those readers to see the opportunity in learning more on the disciplines and literature strands that are new to them. In fact, the conviction that the confrontation of familiar literature with unexplored fields is an added value for any academic discipline was one of the main motivations for choosing a primarily political analysis of a primarily economic instrument as the topic of this PhD study.

The second limitation relates to the case study carried out in **paper 1**. The Chinese case study was conducted based on desktop research and the experiences of my co-author in Chinese policy-making processes. In a similar research design in the future, interviews and other fieldwork could be added to further improve the empirical findings. Empirical evidence would decidedly make the claims made in paper 1 more credible. I give three examples. First, the claim that China's institutional capacity to organize a new market is insufficient, deserves testing. At the time of writing of this concluding chapter (second half of 2017), the experience with the

Chinese pilot emission trading schemes could be empirically examined. Second, the claim that the chosen system of grandfathering would seriously limit the pilots' efficiency should be tested. Finally, the question whether the design of any (efficiency-based) ETS in China is ambitious enough for realizing peak emissions followed by an absolute reduction should be answered empirically.

In a similar vein, in **paper 3**, an empirical case on the impact of environmental taxation of technological development and behaviour change would have contributed to testing the hypotheses regarding the potential of ET for sustainability transitions. Although testing the impact of ET in the long run is a methodological challenge, empirical data could have provided indications in favour of (or against) the claim that ET can have a positive impact on a sustainability transition in the long run.

A fourth limitation is the use of the newly developed indicator for measuring the greening of the tax system in **paper 2**. Although the indicator has a higher validity than the traditional indicators, it could further be improved. One improvement to focus on in the future is the development of a method for adding new environmental taxes and tax rate differentiation to the basket of environmental taxes. Another limitation of the new indicator is its complexity, which implies that only government administrations willing to learn and invest in the methodology will be able to use it.

A fifth limitation is related to the survey in **paper 4**. Because of budget reasons, a separate survey could not be set up. I am thankful to my co-authors for adding a part on environmental taxes in their existing survey cycle, but obviously, the room for adding questions to the survey was limited. On the other hand, some of the variables used in the 'general' part of the survey, such as personal and socio-economic parameters, were also useful for my research. Furthermore, the use of quota sampling instead of a probability sampling technique could cause some bias and in a future edition more measures could be added to reduce the social desirability bias.

6 | Recommendations for further research

The knowledge about the implications of the use of environmental taxation is still very incomplete, especially in the case of persistent and complex environmental problems, such as climate change. Policy impacts depend on many landscape elements, design choices and interactions with other policies and other trends, economic and geopolitical developments etc. In this section, a future research agenda is presented, based on the results of the PhD study, on its contributions and on its limitations. The research agenda is presented in a flowchart that is an extended version of figure 1 of the introducing chapter.

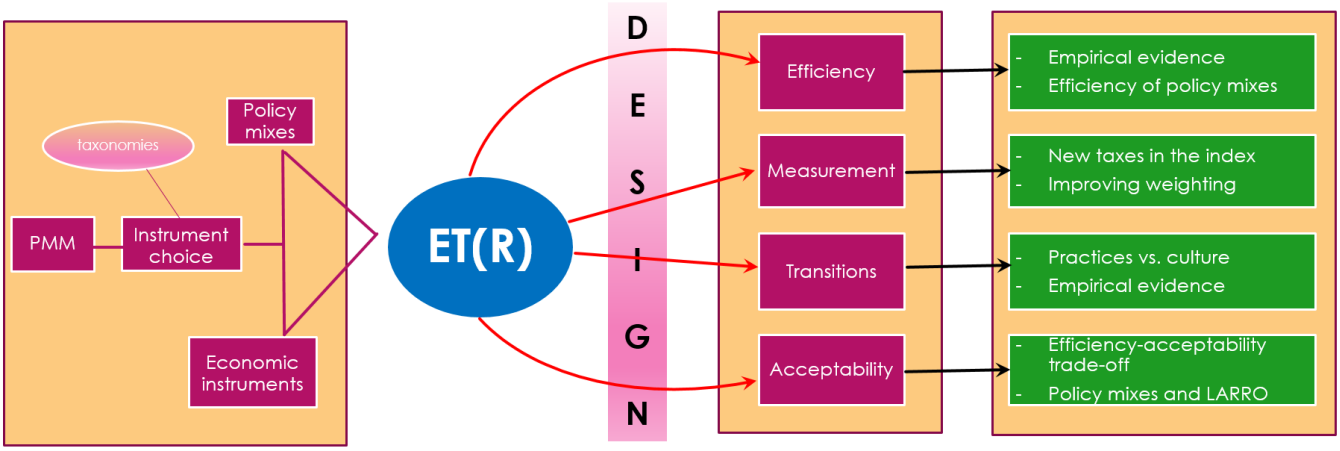

Figure 10. Future research agenda

A first area where future research is needed is on the impact of policy mixes. Many merits and deficiencies of the use of various types of policy mixes have been identified, but the interference of policy goals, policy instruments, policy processes, stakeholder involvement and exogenous development makes for such a complex and unpredictable cocktail that many blind spots remain. A first example is how the difference between *policy layering* versus *policy packaging* affects the impact of a policy mix. A second example is how much of the efficiency of a policy mix is left if a new ET is allowed to co-exist with environmentally harmful subsidies (e.g. on the production or the use of fossil fuels). This research project could be exclusively focused on the place of ET in policy mixes, or could be a broader project with a perspective on all instruments, policy strategies and policy processes that can be part of a policy mix.

A second area for future research relates to the development of indicators for the greening of a tax system. Although the index-type, aggregate tax rate-based indicator developed in this PhD study is a methodological step forward, further in-depth analyses on the issues of weighting and introduction of new taxes in the aggregate tax-rate based indicator is recommended. An ambitious study would aim at the development of an aggregated indicator measuring the greening of national tax systems in a comparative way. The real challenge there is to find a basket of environmentally related taxes that would (1) exist in a large number of countries, with available data on the tax rates and the revenues, and (2) be representative to all environmentally related taxes in each country (i.e. be important in monetary terms). That (set of) indicator(s) would be a full (and better) alternative for the dominant revenue-based indicators use by OECD and Eurostat today, and could replace them.

A third area relates to the link between environmental taxation and sustainability transitions. Further research is needed on (at least) three outstanding questions. First, on the distinction between practices and culture within the transitions thinking school. Second, on the best policy mixes for fostering sustainability transitions. And third, the theoretical claims made in this PhD studies can be regarded as new hypotheses, which call for empirical evidence. In particular, the hypothesis that government, policy instruments and ET can make a positive and significant contribution to sustainability transitions, needs empirical testing. These research objectives can be combined with the research on policy mixes as described in the first area of research. The study of the effects of using ETR within a well-designed policy mixes are thus subdivided in a short-term research line and a research line on the long-run impact and on sustainability transitions. The proposed research programme should ideally combine quantitative research

methods to measure impacts and qualitative methods to identify the success and failure factors and to propose improvements in existing policy designs.

A fourth area concerns the social acceptability of ET and ETR. Many potential determinants of acceptance are not sufficiently understood yet. There is a need for a better understanding of the acceptability conditions of an ETR. An experimental study on the effectiveness of measures or design choices that tackle the efficiency-acceptability trade-off could aim at transforming an 'efficient but unacceptable' ETR into an 'efficient and acceptable' one. Furthermore, future empirical studies could shed a light on the role of co-benefits of a carbon tax, on ways to convince the public of the effectiveness of environmental taxation, and on the potential of innovative policy mixes, including threshold taxation, trial periods and bonus-malus systems. Theories from behavioural economics should be used in this project to find a policy mix that successfully combines effectiveness, efficiency and public acceptability. The acceptability question should be divided in acceptability for the public versus for policy makers, as these two groups' support, although correlated, depends on different criteria.
Finally, knowledge on the Ladder of Acceptability of Revenue Recycling Options (LARRO) could be expanded by adding smart policy mixes to the recycling options. A more extensive survey than we did focusing exclusively on ETS and its revenue recycling options would strongly enhance the knowledge on the most feasible policy options for the public and the policy makers.

The four areas described could lead to four freestanding research projects or programmes. However, a larger and more integrated research project, containing elements of the four areas, could be designed based on the four trade-offs analysed in section 2.2 of this concluding chapter. The reconciliation between efficiency on the one hand, and acceptability, equity, competitiveness and long-term robustness on the other hand, would be an ambitious yet coherent research goal. A large research programme combining theoretical and empirical research would be a great contribution on the knowledge on the potential of ET and ETR as regulatory policy instruments.

7 | Recommendations for policy makers

As the topic of this PhD study is highly policy-relevant, policy recommendations have been made at various occasions in this dissertation. In this section, the recommendations for policy makers are summarized.

Regarding the instrument choice, the decision should consider the circumstances of the sector and policy field related to the environmental problem that is on the policy agenda. A tax seems to be the preferred option if the following conditions are met:

- in case of limited information on the individual firms' cost curves;
- when markets are absent or problems such as asymmetric information, moral hazard or other market failures are present;
- when the marginal abatement cost curve is steeper than the slope of the marginal damage curve.

In the case of complex environmental problems such as climate change, a policy mix often has advantages a single instrument cannot provide. When considering a policy mix, it is important

for the policy maker to avoid incompatible instruments such as an ETS and an environmental tax to solve the same externality. Moreover, government should have the courage to implement regime destabilizing measures, such as an ET or an ETR. Moreover, before introducing a new ET, policy makers should aim at removing any existing subsidies that have the opposite effect of the new tax in order to increase consistency and efficiency and to avoid overdesign. Policy mixes increase the need for policy coordination, both between government levels (vertical coordination) and between departments (horizontal coordination). This requires an open attitude by both political actors and administrations.

Regarding the optimal design of an ET and an ETR, first, the tax base should be as closely linked to the environmental problem as possible. Proxies can be used as a second-best solution as long as they are not too remotely linked to the externality. Second, the tax rates should heed elasticities: if demand elasticity is high, only a high regulatory tax will have an impact. Third, tax policies should be communicated well in advance, and with a future time horizon, including planned tax rate evolutions. On the other hand, some flexibility needs to be integrated into the design, allowing the policy maker to react to unforeseen developments or to review initial assumptions. Exemptions and reduced tax rates to compensate for financial losses should be kept to a strict minimum, or even to zero. Measures to compensate for undesirable side effects should be situated *outside* the environmental tax design, but *inside* the ETR-design. In other words, alleviating side effects should be done through revenue recycling design, as this avoids erosion of the environmental effectiveness of the ET.

Public acceptability is important for an ETR to get approved on the political level, and to survive more than one political term. To raise acceptability, first, a significant part of the revenues should be hypothecated to the environment. Second, a large and transparent communication campaign is needed to convince the public of the environmental effectiveness of the policy mix and to raise people's trust in government. The focus should be on long-term acceptance of the principles of an ETR, so it can be a topic of political consensus instead of divide. Third, part of the revenues should be used for compensating financially vulnerable households. Fourth, insights from behavioural economics should be integrated in the policy design, including salience, framing and the endowment effect. And fifth, excessive complexity should be avoided as this may impair public support.

In sum, policy makers can lead society by implementing an ambitious policy mix to tackle persistent environmental problems such as climate change. In many cases, an ETR will be part of the optimal policy mix. To overcome some of the barriers of ETR, which are mostly related to real or perceived negative side effects, a hybrid instrument, consisting of an ETS with a built-in price floor that operates as a tax, supplemented with smart revenue recycling options, could offer a compromise. The policy maker's task is to design a policy mix which balances out all the societal perspectives that are at stake without compromising the current and next generations entitlement to the public good that the environment is.

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* This reference list only contains the references for the introduction chapter and the conclusions chapter. The reference lists for paper 1, 2, 3 and 4 can be found after the respective papers.

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Appendix 1. Extended table of environmental policy instruments

Table 12. Extended table of environmental policy instruments

Negative	positive
Environmental permit/ licence	legalization
Performance standard, e.g. On the car fleet of one brand.	Exception on regulation / low-regulation zone'[1]
Emission standard - For an individual country; - For a new car; - For a car entering an urban zone[2]	Labelling: - Product labelling (energy efficiency, organic food, ... - Process labelling Energy performance certificate for buildings
Fuel efficiency standard	Dissuasion campaign
Energy efficiency standard: - For heating devices; - For other electrical devices; - For houses and buildings	Awareness/information campaign
Quota (= non-tradable permit): - Fishing quota - Vehicle quota	Sensitisation campaign
Ban or prohibition on production input or output.	Voluntary agreement (co-regulation)
Prescription or obligation	Naming and faming
Legislation	Early warning system
National emission target	Voluntary code for economic sectors (e.g. green buildings)
Education attainment targets for schools	Voluntary environmental standard (ISO 14001)
Technology standard: BAT and BATNEEC	Recommendation
Litigation facilitation	Leading by example: - Green procurement and tendering; - Greening of building stock; - Greening of transport - Divestment - Greening export credits, guarantees and insurance
Zoning / location control	Nudges[3]
Naming and shaming	Carbon offsets scheme
Tax, charge, fee: - Emissions tax - Waste charge (collection, recycling, incineration, landfill)	Subsidy: - Export credits - Energy subsidies - Purchase subsidies

- / wastewater/ effluent charges - User charges/ toll (e.g. road pricing) - Resource taxation - Input taxes (pesticides, energy) - Resource rent taxation (royalties) - Product / purchase / consumption taxes: includes excise taxes, but not VAT. - Production tax - Energy tax - Carbon tax - Fine / non-compliance fee, e.g. for noise standard violations - Pollution tax (e.g. air pollution) - Tax border adjustment - ETR - Noise charge - Deforestation charge - Access fee - Land use tax	- Manufacturing subsidies - Public transport subsidies - R & D subsidies
Tradable permit scheme (grandfathered or auctioned): - Emissions trading - Tradable emission reduction credits - Personal carbon budget - Tradable quotas (e.g. catch quotas) - Tradable performance standards[4] - Tradable land rights/ land permits (development quotas) - Tradable water shares - Tradable offsets - Tradable reforestation credits - Tradable conservation credits	Government guarantees/insurance: - Credit guarantee for environmental business (revolving funds) - Green export credits
Removal of EHS	Tax expenditure: rebate, tax differentiation, exemption, tax deduction, accelerated write-off
Liability scheme[5], compensation fund, environmental liability insurance	Tax compensation scheme
performance bond[6]	Feed-in tariff, green certificates scheme
White certificates scheme [7]	Concessional (soft) loan - Revolving green fund - Sector fund
	Prize
Deposit-refund scheme	
Bonus-malus scheme	

Sources: R. C. Anderson (2002), Bennear and Stavins (2007), Fischer (2001), Perman et al. (2003), Sorrell et al. (2009), UNDESA (2012), UNEP (2004) and Steuwer (2013).

Direct provision is not included, nor are organizational instruments.

1. Nudging is information provision aimed at behavioural change that is not trying to make people more aware, but instead focuses on changing the environment in which a consumer decision is made, which may influence the choices made by people's 'automatic minds'. For example, changing the default option for electricity supply for a family in a form to 'renewable energy'; only few people will take the effort to change the default option (Ölander & Thøgersen, 2014).
2. Example: the objective to reduce the amount of airplane catering waste going to landfill and incineration is seriously hampered by the fact that, according to the Guardian, "*At the moment EU animal health legislation, drawn up as a reaction to diseases like foot and mouth, dictates that all catering waste arriving from outside EU borders be treated as high-risk and incinerated or buried in deep landfill*." (https://www.theguardian.com/sustainable-business/2017/apr/01/airline-food-waste-landfill-incineration-airports-recycling-iberia-qantas-united-virgin, accessed April 29, 2017).
3. Such as currently in the city of Antwerp.
4. Example: the 1982 lead phase out programme in the US, which set an inter-refinery average (a 'cap') on importers and refineries; trading between underusing and overusing firms was allowed (Fischer, 2001).
5. Obligation to set-up financial mechanisms (compensation fund) in case of environmental damage or negligence in clean-up (in case of resource extraction), usually from the beginning of an activity.
6. The only difference between a performance bond and a liability scheme, is that the latter is a fund that is set-up by the company, while in the former case the company needs to pay the fee to the government, in which case it is comparable to a deposit-refund scheme. Stavins (2001) regards a performance bond as a type of insurance premium tax. Both instruments are regularly used in the context of mining activities (R. C. Anderson, 2002).
7. White certificates are certificates to certify energy savings by energy suppliers (Sorrell et al., 2009; Steuwer, 2013).

Summary

This PhD study makes an in-depth analysis of the use of environmental taxation as a regulatory policy instrument. It is based on insights from both social and political science and economics. The central research question is "*How can the use of ET as a regulatory policy instrument be **explained**, **measured** and **optimized**?*" This question harbours several underlying research questions, which are elaborated in an introductory chapter, four academic publications, and a concluding chapter.

In the **Introduction**, an analysis is carried out of the most important policy-making models, which explain how policy decisions come about. The instrument of environmental taxation is fit into these models. Subsequently, a taxonomy of policy instruments is developed, based on different criteria such as the control model. Finally, instrument choice by policy makers is explained, both in theory and in practice.

In **Paper 1**, the taxation instrument is compared with emissions trading in the context of climate policy, both in theory and in a case study on China. Although the theoretical potential of both instruments is similar, carbon taxation appears to be the better option for the case of China, taking into account design complexity and the limited institutional capacity and experience.

In **Paper 2**, the existing indicators for measuring the greening of a tax system are evaluated and a new type of aggregated indicator is developed, based on index theory. Although the validity of the new aggregate indicator is higher than the dominantly used revenue-based indicators, a number of validity issues remain, and complexity can be a burden for its use by government agencies. Ideally, the greening of a tax system will be evaluated by by using a set of indicators, including the revenue-based indicators, single tax rates, the new aggregate tax rate-based indicator, and the implicit tax rate on energy.

In **Paper 3**, the theory of environmental taxation is confronted with the theory of sustainable transitions thinking. Environmental taxation was found to have the highest potential for realizing long-term changes in technological development and social practices. Furthermore, the optimal impact is expected to occur when environmental taxation is used in a policy mix, along with other policy instruments, policy strategies and policy processes.

In **Paper 4**, public support for environmental taxation is studied, both in theory and empirically, based on a survey in Flanders. Support is lower for taxes that are specified in detail. Education, income and environmental concern were found to be determinants of higher support. Revenue-recycling options can be ranked in the 'Ladder of Acceptability of Revenue Recycling Options' (LARRO), with environmental expenditures receiving the highest support.

In the **concluding chapter**, transversal conclusions for the use of environmental taxation as a regulatory instrument are presented. Trade-offs were found between efficiency on the one hand, and acceptability, equity, competitiveness, and long-term robustness on the other hand. The use of policy mixes and accurate policy design are crucial success factors for environmental taxation. A future research agenda could be constituted through a comprehensive and integrated research programme, in which all trade-offs are analysed and empirical evidence is

gathered for improved knowledge regarding the use of environmental taxation as a regulatory policy instrument.

Samenvatting

Deze doctoraatsstudie maakt een diepteanalyse van het gebruik van milieubelastingen als een sturend beleidsinstrument. Het is gebaseerd op inzichten uit zowel sociale en politieke wetenschappen als uit economie. De centrale onderzoeksvraag is "*Hoe kan het gebruik van milieubelastingen als sturend beleidsinstrument worden **verklaard**, **gemeten** en **geoptimaliseerd***?" Deze vraag herbergt meerdere onderliggende onderzoeksvragen, die worden uitgewerkt in een inleidend hoofdstuk, vier academische publicaties en een concluderend hoofdstuk.

In de **Inleiding** wordt een analyse uitgevoerd van de belangrijkste beleidsmodellen, die verklaren hoe beleidsbeslissingen tot stand komen. Het instrument van milieubelastingen wordt ingepast in deze modellen. Vervolgens wordt een typologie van beleidsinstrumenten ontwikkeld, gebaseerd op verschillende criteria, zoals het sturingsmodel. Ten slotte wordt instrumentenkeuze door beleidsmakers verklaard, zowel in theorie als in praktijk.

In **Paper 1** wordt het belastingsinstrument vergeleken met verhandelbare emissierechten in de context van klimaatbeleid, zowel in theorie als in een casestudy over China. Hoewel het theoretische potentieel van beide instrumenten vergelijkbaar is, blijkt een koolstofbelasting de betere optie voor de case van China, rekening houdend met de complexiteit van het design en de beperkte institutionele capaciteit en ervaring.

In **Paper 2** worden de bestaande indicatoren voor het meten van de vergroening van het belastingsysteem geëvalueerd, en wordt een nieuw type van geaggregeerde indicator ontwikkeld, gebaseerd op indextheorie. Hoewel de validiteit van de nieuwe samengestelde indicator hoger is dan de meest gebruikte inkomstengebaseerde indicatoren, blijven een aantal validiteitsproblemen bestaan, en de complexiteit kan een last zijn bij het gebruik door overheidsactoren. Idealiter wordt de vergroening van het belastingstelsel beoordeeld aan de hand van een set van indicatoren, waaronder de inkomstengebaseerde indicatoren, individuele belastingtarieven, de nieuwe samengestelde indicator en het impliciete belastingtarief op energie.

In **Paper 3** wordt de theorie van milieubelastingen geconfronteerd met de theorie van duurzaamheidstransities. Milieubelastingen blijken het grootste potentieel te hebben in het realiseren van technologische ontwikkeling en sociale praktijken, beide op de lange termijn. Daarnaast wordt de optimale impact verwacht van het gebruik van milieubelastingen in een beleidsmix, in combinatie met andere beleidsinstrumenten, -strategieën en -processen.

In **Paper 4** wordt het maatschappelijk draagvlak voor milieubelastingen bestudeerd, zowel in theorie als empirisch, op basis van een enquête in Vlaanderen. Het draagvlak bij het publiek is kleiner wanneer de taksen met veel detail worden gespecificeerd. Scholingsgraad, inkomen en milieuattitude blijken determinanten te zijn voor hogere steun. De bestedingsopties voor de inkomsten kunnen in een rangschikking worden geplaatst, in de 'Ladder of Acceptability of Revenue Recycling Options' (LARRO), waarin uitgaven voor milieu de hoogste steun genieten.

In de **conclusie** worden transversale besluiten voor het gebruik van milieubelastingen als sturend beleidsinstrument voorgesteld. Trade-offs of afruilen werden gevonden tussen enerzijds efficiëntie, en anderzijds aanvaardbaarheid, rechtvaardige verdeling, competitiviteit en robuustheid op de lange termijn. Een onderzoeksagenda voor de toekomst zou de vorm kunnen krijgen van een uitgebreid en geïntegreerd onderzoeksprogramma, waarin alle trade-offs worden geanalyseerd en empirische onderbouwing worden gezocht voor een betere kennis omtrent het gebruik van milieubelastingen als sturend beleidsinstrument.

Résumé

Cette étude doctorale fait une analyse en profondeur de l'usage des taxes environnementales en tant qu'instrument politique dirigiste. Elle est basée sur des notions tant sociales et politiques qu'économiques. La question étudiée est "Comment l'usage de taxes environnementales en tant qu'instrument politique dirigiste peut-il elle être **expliqué**, **mesuré** et **optimalisé**?" Cette question comprend plusieurs questions sous-jacentes, qui sont élaborées dans une introduction, quatre publications académiques et une conclusion.

Dans **l'introduction,** une analyse des modèles politiques les plus importants est effectuée. Ces modèles expliquent comment les décisions politiques sont prises. L'instrument des taxes environnementales est cadré dans ces modèles. Ensuite, une typologie d'instruments politiques est développée, basée sur plusieurs critères, comme le modèle de commande. Enfin, le choix des instruments est expliqué, tant en théorie qu'en pratique.

Dans le **Papier 1**, l'instrument des taxes est comparé avec un système d'échange des droits d'émissions dans le contexte des politiques en matière de climat, tant en théorie que dans le cas de la Chine. Bien que le potentiel théorique des deux instruments soit comparable, une taxe carbonne se trouve être la meilleure option pour le cas de la Chine, compte tenu de la complexité de l'élaboration des politiques et des capacités institutionnelles limitées.

Dans le **Papier 2**, les indicateurs existants pour la mesure du verdissement du système fiscal sont évalués, et un nouveau type d'indicateur agrégé est développé, basé sur la théorie des indices. Bien que la validité du nouvel indicateur agrégé soit supérieure à celle des indicateurs de référence, un nombre de problèmes de validité restent pertinents, et la complexité peut être une charge importante auprès des utilisateurs. L'évaluation du verdissement du système fiscal sera faite idéalement sur base d'un ensemble d'indicateurs, dont les indicateurs de recettes, les taux d'imposition individuels, le nouvel indicateur agrégé et le taux d'imposition implicite sur l'énergie.

Dans le **Papier 3**, la théorie des taxes environnementales est confrontée à la théorie des transitions durables. Les taxes environnementales semblent avoir le potentiel le plus important par rapport à la création de développements technologiques et au changement de pratiques sociales, au long terme. Par ailleurs, l'impact optimal est attendu de la mise en oeuvre des taxes environnementales au sein d'un 'policy-mix', en combinaison avec d'autres instruments, stratégies et processus politiques.

Dans le **Papier 4**, le soutien public envers les taxes environnementales est étudié, tant en théorie que de façon empirique, sur base d'un questionnaire en Flandre. Le soutien public est moins important si les taxes sont spécifiées en détail. Le niveau scolaire, le revenu et l'attitude environnementale s'avèrent être des déterminants importants pour le soutien. Les options de dépense pour les recettes peuvent être classées dans un classement ('ranking'), dans 'l'échelle d'acceptabilité des options de recyclage des recettes' (LARRO), dans laquelle les dépenses pour l'environnement bénéficient du soutien le plus important.

Dans la **Conclusion**, des conclusions transversales pour l'utilisation des taxes environnementales en tant qu'instrument politique dirigiste sont présentées. Des compromis ont été trouvés entre – d'une part – l'efficacité, et – d'autre part – l'acceptabilité, l'équité, la compétitivité et la robustesse au long terme. Un programme de recherche futur pourrait se baser sur l'analyse de ces compromis et sur la justification empirique, afin d'obtenir une meilleure connaissance par rapport à l'usage des taxes environnementales en tant qu'instrument politique dirigiste.

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